Portsmouth Harbor — Piscataqua River

New Hampshire and Maine

Channel Improvements For Deep-Draft Navigation

Stage 2 Documentation

Prepared For Checkpoint 1 Conference

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United States Army
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—Serving the Army
—Serving the Nation

New England Division

SECTIONS ~~OF~~
STAGE 2 DOCUMENTATION

INTRODUCTION

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This report consists of Stage 1 and Stage 2 study findings and has been prepared to meet the requirements for the Stage 2 Checkpoint Conference. This report is not intended to be a public document and should not be released as such.

The study of the Portsmouth Harbor-Piscataqua River area has as its objective the determination of the feasibility of improving the existing Federal channel by dredging.

Portsmouth, New Hampshire, is located on the south bank of the Piscataqua River opposite Seavey Island and the town of Kittery, Maine, 56 nautical miles southwest of Portland, Maine, and 61 nautical miles northeast of Boston, Massachusetts. The river, formed by the confluence of the Salmon Falls and Cocheco Rivers, flows 13 miles generally southeast to the Atlantic Ocean, and forms a portion of the boundary between the States of Maine and New Hampshire. The mouth of the river is known as Portsmouth Harbor.

Development of the Portsmouth Harbor-Piscataqua River area has been closely linked with the progressive development of deep-draft navigation on the river. The major shipping terminals located along the south bank of the river in New Hampshire now handle over 3 million tons of dry bulk, liquid bulk, containerized and general cargo each year. Petroleum products constitute the major portion of this waterborne commerce. In addition, the Piscataqua River is an important resource from a military standpoint in that it helps to provide for some of the needs of the naval and air force facilities located along its banks.

The size of the deep-draft vessels utilizing the existing 35-foot deep Federal channel in the Piscataqua River has been gradually increasing. At the present time, it appears to have reached a critical point whereby the safety of the deep-draft vessels utilizing the channel has become a major concern. The adverse physical conditions including sharp bends, treacherous currents, and hard channel bottom and side slopes all combine to make navigation extremely difficult, especially for the larger deep-draft vessels. A major mishap in the channel could result in excessive economic and environmental losses, cause the channel to be closed to vessel traffic for an indefinite period of time or even result in the loss of life.

In order to allow for the continued growth and development of the port and at the same time maintain its excellent safety record, local interests have requested that improvements be made to the existing Federal channel. It is felt that if the channel is improved in certain specific areas navigation on the river would be made a lot safer for the existing fleet and even allow for a slight increase in future vessel size.

I. STUDY AUTHORITY

Recognizing the economic importance of deep-water channels, the Committee on Public Works of the U.S. Senate at the request of local interest adopted a Resolution on 23 April 1970, authorizing a study to determine the advisability of making improvements to the existing project. The Resolution reads as follows:

> "RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE UNITED STATES SENATE, the Board of Engineers for Rivers and Harbors, created under the provisions of Section 3 of the River and Harbor Act approved June 13, 1902, be, and is hereby requested to review the report of the Chief of Engineers on Portsmouth Harbor and Piscataqua Rivier, Maine and New Hampshire, published as House Document Numbered 556, Eighty-Second Congress, and other pertinent reports, with a view to determining whether any modifications of the existing project are advisable at the present time."

On 23 June 1976, the U.S. Senate provided funds for the first stage in the development of a feasiblity study and environmental impact investigation to commence on 1 October 1976.

II. SCOPE

At the time this study was initiated, local interests requested that three areas along the Federal channel in the Piscataqua River be evaluated in detail. They think these areas are particularly hazardous to deep-draft navigation and are in need of immediate improvement to avoid a major catastrophe.

In order to be responsive to the needs and desires of local interests, the first stage of the study effort concentrated on investigating the feasibility of improving the three critical areas designated by local interests. Preliminary investigations assessed the immediate and future needs of the deep-draft navigation interests along the Piscataqua River in relation to the existing and future economic, environmental, cultural, and sociological conditions and considerations. These initial investigations were conducted to determine whether or not there was sufficient justification to warrant conducting a full-scale feasibility study and environmental investigation. The initial findings which are contained in the Plan of Study entitled, "Portsmouth Harbor-Piscataqua River, New Hampshire and Maine, Channel Improvements for Deep-Draft Navigation," dated May 1978, indicated that improvement of two of the areas appeared to be economically feasibile and it was recommended that the study proceed to Stage 2. The third area, located at the head of the Federal channel, was not given a great deal of consideration during the first stage of the study due to the fact a determination was made early in the study that it would serve only one user and, therefore, would not qualify for Federal assistance in an improvement project under existing policy.

During Stage 2, the scope of the study has been expanded to include alternative measures such as: modifications of the Maine-New Hampshire interstate bridge; nonstructural measures such as offshore lightering, transshipment, traffic management and pilot regulation. Also, more detailed analyses were conducted on the channel improvements examined in the Plan of Study and a preliminary investigation of the turning basin located at the head of the channel.

The plans presented in this report have been formulated and evaluated in close coordination with other Government agencies, interested groups, and individuals.

III. STUDY PARTICIPANTS AND COORDINATION

The advisability of making improvements to the existing Federal channel in the Piscataqua River due to its very nature necessitates close coordination between the Corps of Engineers and other Federal, State and local agencies, private industry, associations, and individuals.

This is very aptly pointed out by the fact that an ad hoc committee known as the Portsmouth Harbor-Piscataqua River Safety Improvement Committee was formed in 1976 and was instrumental in getting monies appropriated for initiation of the study in FY77. The committee is composed of representatives from Maine and New Hampshire State agencies, local community representatives, waterway users and the Portsmouth Harbor pilots. To date the committee has been very helpful in organizing workshop meetings, acquiring data and providing input to the study effort, and acting as a liason among all interests. The study was initiated with the issuance of a public notice on 15 November 1976. Stage 1 of the study effort culminated with the preparation of the Plan of Study in May 1978. During this preliminary study effort several informal workshop meetings were held. The Plan of Study was approved in July 1978.

During the Stage 2 study effort two workshop meeting have been held with the Portsmouth Harbor-Piscataqua River Safety Improvement Committee to discuss the status and progress and make arrangements for obtaining input to the study effort. Along with members of the Improvement Committee the workshops were attended by local and State officials. All those in attendance felt that at the very minimum improvements must be made to the turning basin between the two vertical lift bridges. Representatives of the U.S. Navy felt that removal of ledge in the vicinity of Goat Island would be extremely beneficial.

Throughout, communication and correspondence has been maintained with the U.S. Fish and Wildlife Service, Concord Area Office; Environmental Protection Agency; Department of Health, Education and Welfare; National Marine Fisheries Service; State of Maine, Department of Environmental

Protection; Resource Planning Division, State of Maine Planning Office; Special Board, State of New Hampshire; and the Greater Portsmouth Chamber of Commerce.

IV. PRIOR STUDIES AND STUDIES OF OTHERS

This section presents studies and reports by the Corps and other Federal and non-Federal agencies that have a bearing on this study. Data, conclusions and recommendations made have been incorporated elsewhere in the report.

Prior Studies

The Corps of Engineers has been very instrumental in the progressive development of the existing 35-foot deep Federal channel in Portsmouth Harbor and the Piscataqua River. To date, several Congressionally authorized navigation improvement studies have been conducted for the area by the Corps. A number of these have resulted in Federal projects in the Piscataqua River that now provide for a 35-foot deep channel, turning basins for large vessels, and a breakwater to help control the swift currents in the river. A summary of the prior navigation reports that have been prepared by the Corps is presented in Table 1.

PRIOR REPORTS PREPARED BY THE CORPS OF ENGINEERS

Table 1

Document Published in	Report Date	Work Evaluation and Recommendations
H. Ex. Doc. No. 84, 43d Cong., 1st Session	Preliminary Examination 1873	Breakwater between Gerrish and Wood Islands. Estimated cost $150,000. Favorable.
Sen. Ex. Doc. No. 39, 45th Cong., 3d Session	Survey 1878	Closing channel between New Castle Island and Goat Island to eliminate strong currents. Remove portion of Gangway Rock to 20 feet below mean low water and remove part of Badgers Island to 10 feet at mean low water. Favorable.
Sen. Ex. Doc., No. 30, 47th Cong., 1st Session	Preliminary Examination and Survey. 1882	Extension and completion of breakwater between Goat Island and New Castle Island. Unfavorable.
Sen. Ex. Doc. No. 44, 48th Cong., 1st Session	Preliminary Examination and Survey. 1883	Construction of dam near mouth of Great Bay to maintain high water level navigation above and eliminate strong currents below. Unfavorable.
H. Ex. Doc. No. 71, 48th Cong., 2nd Session	Preliminary Examination 1884	Improvement of Portsmouth Harbor. Unfavorable
H. Doc. No. 39, 56th Cong., 1st Session	Preliminary Examination 1899	Removal of "Pull-and-Be-Damned Point." Unfavorable
H. Doc. No. 263, 56th Cong., 2nd Session	Preliminary Examination and Survey 1900	Remove portion of Henderson Point to improve navigation into Navy Yard at Kittery. Favorable - Completed by Navy

H. Doc. No. 1086, 61st Cong., 3d Session	Preliminary Examination (Review of Reports) 1909	Construction of lock and dam in Piscataqua River. Unfavorable
H. Doc. No. 1010, 64th Cong., 1st Session	Preliminary Examination 1915	Removal of South Beacon Shoal, part of shoal off Badgers Island, part of Gangway Rock, Goat Island and Seaward Rock, all to a depth of 30 feet below mean water. Unfavorable.
H. Doc. No. 566 82d Cong., 2d Session	Survey (Review of Reports) 1952	Removal of ledge rock in the vicinity of Gangway Rock, the southwest point of Badgers Island and Boiling Rock to 35 feet below mean low water. Favorable
H. Doc. No. 482 87th Cong., 2d Session	Survey (Review of Reports) 1962	Widening the 35-foot Federal channel at five locations and extending the channel upstream from Boiling Rock to a point about 1,700 feet above the Atlantic Terminal sales dock in Newington, generally 400 feet wide and 35 feet deep below mean low water with maneuvering basins above Boiling Rock, and at the head of the project. Favorable.
	Small Nav. Project Detailed Project Report 1965	A channel 100 feet wide and 6 feet deep from Little Harbor through the Rye-New Castle drawbridge, and then in a northerly direction between the mainland and Leachs Island to natural deepwater area south of the bridge between Shapleigh and Goat Islands. A channel 75 feet wide and 6 feet deep up Sagamore Creek to the Sagamore Avenue Bridge with anchorage in strips 75 feet wide 6 feet deep, totaling 3 acres adjacent to the upper reach of the channel. Favorable.

In addition to this Congressionally authorized navigation improvement study for Portsmouth Harbor and the Piscataqua River, the Corps completed a reconnaissance report in June 1979 that evaluated the feasibility of constructing a small boat navigation project in the area of Kittery, Maine. The study evaluated the feasiblity of providing an access channel of adequate depth to accommodate commercial fishing vessels up to 90 feet in length extending from the Piscataqua River channel to a town-owned site at the foot of Rice Avenue, along with a turning basin at the head of the channel of equal depth to facilitate the movement of vessels in and out of the area. The preliminary study findings indicated that a small navigation project in the area was feasible and it was recommended that a detailed study of the area be conducted. After being advised of the study findings, the local interests have requested that the study be held in abeyance to give them time to determine whether any other land sites exist in the area to accommodate their proposed land-based facility.

At the present time, in addition to these navigation studies, the Corps is conducting a study in southeast New Hampshire to identify water resource needs and problems with a strong emphasis on water supply. A total of 50 communities and approximately 1,000 square miles of the New Hampshire coastal area and the Piscataqua River Basin are included in the study area. The first stage of the study culminated with the preparation of a reconnaissance report entitled "Southeastern New Hampshire Water Resources Study," dated May 1979.

Studies by Others

In addition to the reports that have been and are being prepared by the Corps, the New England River Basins Commission is in the process of preparing a summary report for the Piscataqua and New Hampshire Coastal River Basins. The intent of the report is to establish a uniform information base with respect to demands on water resources, problems associated with the use of the resource, and programs and projects relevant to the management of the water resources. The study will concentrate on identifying gaps in the existing network of planning and resource management programs, and advancing recommendations to correct these deficiences. The overview report can be used as a guide for additional planning. In addition, it can be used to assist in the coordination of State and Federal planning efforts, provide the basis for the investigation of interstate resource issues, and give support to the Commission for its annual priority program. The report itself will not consider a range of alternatives to resolve the problems that were identified.

In addition to the above mentioned on-going studies being conducted by the Corps of Engineers and the New England River Basins Commission, a number of other reports have been prepared for the area by the Soil Conservation Service, the Environmental Protection Agency, the U.S. Geological Survey, the Maine Department of Environmental Protection, the New Hampshire Water Supply and Pollution Control Commission, along with several regional planning associations.

V. THE REPORT AND STUDY PROCESS

The initial steps in the study process include a comprehensive inventory of available information, performance of seismic investigations and preparations of base plans. Extensive efforts were expended to contact public officials and interested parties to provide information and to seek public input into the study process. Based upon available information, baseline conditions were determined to formulate the planning objectives and constraints. Preliminary improvement plans were developed and evaluated. These were presented to local public officals and interested groups at various public workshops.

The final survey report will consist of a Main Report and supporting appendices. The body of the Main Report is structured in accordance with the planning process followed during the course of the study. It is organized as follows: Problem Identification, Formulation of Preliminary Plans, Assessment and Evaluation of Detailed Plans, Comparison of Detailed Plans, and an Environmental Assessment.

PROBLEM IDENTIFICATION

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The main purpose of this section of the report is to describe the nature of the water and related land resource problems, existing in the study area, that will be examined in detail in this study. Several existing problems have been identified within Portsmouth Harbor and the Piscataqua River Basin area, both by this study and the other on-going Corps study entitled, "Southeast New Hampshire Water Resources Study." These problems include, but are not limited to the areas of water supply, water quality, coastal and riverine flooding, navigation and recreation. Due to the nature of the resolution under which this study was authorized, and in order to avoid a duplication of effort and expenditures, this study will concentrate on problems associated with deep-draft navigation on the Piscataqua River, the other Corps study will address the other water and related land resource management problems that have been identified in the area, with the main emphasis being placed on water supply.

I. NATIONAL OBJECTIVES

The Corps of Engineers multiobjective planning process for feasibility studies for water and related land resources is geared to achievement of the national objectives of National Economic Development (NED) and Environmental Quality (EQ). These national objectives may be thought of as goals to be obtained as a result of the planning process. The NED objective is achieved by increasing the value of the Nation's output of goods and services, and improving national economic efficiency. The EQ is achieved by the management, conservation, preservation, creation, restoration, or improvement of the quality for certain natural and cultural resources and ecological systems.

The components of the NED objective include: (1) the value of increased outputs of goods and services resulting from a plan; (2) the value of output resulting from external economics associated with a plan. The components of the EQ objecitve include: (1) management, protection, enhancement, or creation of areas of natural beauty and human enjoyment; (2) management, preservation or enhancement of especially valuable or outstanding archeological, historical, biological, and geological resources and ecological resources and ecological systems; (3) Enhancement of quality aspects of water, land, and air by control of pollution or prevention of erosion and restoration of eroded areas; (4) avoiding irreversible commitment of resources to further uses.

These national objectives should not be confused with the study planning objectives which are normally defined as the national, State and local water and related land resource management needs (opportunities and problems) specific to a given study area that can be addressed to enhance NED or EQ. The planning objectives that have been established for this study are discussed later in this section.

II. THE STUDY AREA

The Piscataqua River forms a portion of the boundary line between the States of Maine and New Hampshire. Portsmouth Harbor, located at the mouth of the river, is about 45 miles sailing distance northeast of Boston Harbor, Massachusetts, and 37 miles sailing distance southwest of Portland, Maine.

The river is about 13 miles long and has a tortuous channel that winds around sharp bends and over submerged ledges, making navigation hazardous. The river begins at the confluence of the Salmon Falls and Cocheco Rivers. These latter rivers are navigable for small boats and have controlling depths of 7 feet for distances of about 1 mile and 2-1/2 miles, respectively. Below the confluence, the Piscataqua River flows in a southern direction for about 4 miles to a point where it receives the discharge of a 12 square-mile tidal basin consisting of Great Bay and its tributary river. Within this 4-mile reach the Piscataqua River has a natural channel about 400 feet wide in which depths vary from 9 to 28 feet, with 9 feet being the controlling depth in the upper half of the channel and 20 feet in the lower half. Below the junction with the Great Bay water system, the Piscataqua River swings southeast for a distance of about 3,000 feet in which the depth of the natural channel is in excess of 40 feet. The head of the existing Federal channel, at the upstream end of this deep channel, is approximately 1,700 feet above the ATC Petroleum dock in Newington, New Hampshire. From this point the Piscataqua River extends downstream for about 4-1/2 miles to Portsmouth Harbor, and has a controlling depth of 35 feet generally with a width of 400 feet or greater, including two turning basins. In the lower section of Portsmouth Harbor, channel depths generally are in excess of 50 feet and widths are in excess of 500 feet.

The city of Portsmouth and the towns of New Castle and Newington, New Hampshire in Rockingham County, and the towns of Eliot and Kittery, Maine in York County comprise the land areas included in the study area. The city of Portsmouth which has the greatest influence on the port was settled in 1623 and incorporated in 1849. Its primary development has been as a port city, with facilities for both commercial and military vessels located in the harbor. More recently as highways have been built, particularly Route I-95, southern New Hampshire's ties with Massachusetts have been tightened. Portsmouth's many historical sites, its proximity to the ocean, and its growing cultural resources have attracted many visitors. The region has also been successful in attracting light industrial development and service industries, creating a well-balanced economic base. For these reasons, the region has become important as a residential and vacation area.

Climatology

The climate of the study area is characterized by four distinct seasons with variable weather. Relatively mild summers and winters are the rule in Portsmouth, due to the moderating influence of the Altantic Ocean.

The mean annual temperature in the area is about 45.5°F. The mean low monthly temperature for Portsmouth is 22°F and occurs in January, while the highest monthly temperatures occur in July, averaging 68.4°F.

The study area lies in the path of the "prevailing westerlies" and the cyclonic disturbances that cross the country from west to southwest towards the east to northeast. The area is also subject to occasional violent coastal storms, some of tropical origin, that travel up the Atlantic seaboard. These tropical storms, sometimes known as "Northeasters," are heavily laden with moisture from the ocean, but a great deal of their energy is dissipated before reaching northern New England.

The mean annual precipitation recorded by the U.S. Weather Bureau Station at Portsmouth is 43.51 inches with average monthly precipitation ranging from 2.6 inches to 5.0 inches. The maximum monthly rainfall recorded during 19 years is 13.75 inches and the minimum is 0.30 inches.

Temperature and precipitation readings were recorded by the U.S. Weather Bureau Station at Portsmouth from June 1954 through May 1973. Monthly temperature and precipitation averages are presented in Tables 2 and 3 for this time period.

Table 2

Monthly Temperatures

Portsmouth, New Hampshire

(1954-1973)

(Degrees Fahrenheit)

Month	Mean	Maximum	Minimum
January	22.0	58	-23
February	23.9	64	-15
March	32.5	76	-8
April	42.9	92	10
May	53.6	94	22
June	63.0	96	32
July	68.4	99	35
August	66.5	98	33
September	59.5	93	26
October	49.4	88	14
November	38.7	76	8
December	26.1	60	12
Annual	45.5	99	-23

Table 3

Monthly Precipitation

Portsmouth, New Hampshire

(1954-1973)

(Inches)

Month	Mean	Maximum	Minimum
January	3.6	13.75	.58
February	3.9	6.64	.30
March	3.5	6.21	1.74
April	3.9	12.97	1.41
May	2.9	6.39	1.03
June	3.2	8.59	.81
July	3.1	5.44	1.26
August	2.6	6.71	1.20
September	3.6	9.09	1.41
October	3.8	10.77	.94
November	5.0	9.72	2.43
December	4.4	9.46	.96
Annual	43.51		

Historical - Archeological Features

One of the oldest settlements in New Hampshire, Portsmouth has a charming and quaint atmosphere because many of its historic sites have been preserved. Many buildings and homes dating from the 17th century have been restored and are maintained for public viewing, particularly in the Strawbery Banke section. This area recreates many facets of daily life in the 1600's from typical homes to shops and stores. Shops and restaurants lining Ceres Street, located along the waterfront, have also been restored to reflect the city's colonial marine heritage.

New Castle Island, at the mouth of the river, was the scene of one of the earliest military events of the American Revolution. The Patriot's captured Fort William and Mary from the British on 14 December 1774.

The Portsmouth Navy Yard, established in 1800, is located on Seavy Island within the State of Maine's boundaries. In 1905 the Treaty of Portsmouth, ending the Russo-Japanese War, was signed in the "Peace Building" at the naval base. During the 20th century, the yard became a center for building and repairing submarines. Recent years have seen a decline in use and staff numbers at the Portsmouth base.

There is no evidence to date to suggest the presence of shipwrecks or other features that may be of historic interest within the immediate area of the proposed project.

Fisheries Resources

The Piscataqua River estuary is well established as a preferred location for recreational and sport fishing. Excellent game fish such as striped bass, mackerel, flounder, and coho salmon can be found within the estuary. Rainbow smelt seasonally migrate through the area to spawn in the bays of the upper estuary. These fish are important to both winter sport and commercial fishermen.

The Public Service Company of New Hampshire has conducted environmental monitoring programs in the Piscataqua River estuary each year since 1970. A three-part monitoring program encompassing netting, sonic tracking, and creel censusing has been used since 1971 to identify and determine both relative abundance and behavior of fish species in the area. Table 4 lists common names of species taken from their most recently published report.

While lobster (Homarus americanus) and crab (Carcenedes, Uca and Callinectes spp) appear to be more numerous in the harbor entrance and lower portions of the river, greater numbers of soft-shelled clams (Mys arenaria) and oyster (Corssotria nad Modiolus app) can be found in the Great Bay area. A State of New Hampshire license is required to harvest lobsters, clams and oysters for both commercial and private interests.

Table 4
Finfish Collection 1975
Piscataqua River Estuary

Blueback herring
Alewife
American sand lance
American eel
Fourspine stickleback
Atlantic Menhaden
Cusk
Atlantic herring
Wrymouth
Lumpfish
Fourbeard rockling
Mummichog
Striped killifish
Atlantic Cod
Treespine stickleback
Blackspotted stickleback
Witch flounder
Sea raven
American plaice
Smooth flounder
Sea snail
Goosefish
Cunner
Raidated shanny
Red hake
White hake

Altantic silverside
Silver hake
Atlantic tomcod
Planehead filefish
White perch
Striped bass
Grubby
Longhorn sculpin
Shorthorn sculpin
Coho salmon
Rainbow smelt
Butterfish
Rock gunnel
Pollack
Bluefish
Winter flounder
Ninespine stickleback
Little skate
Brown trout
Brook trout
Atlantic mackerel
Windowpane flounder
Northern puffer
Northern pipefish
Tautog

III. ECONOMIC, CULTURAL, AND SOCIOLOGICAL CONDITIONS

To a large degree the resources of a region determine the status of its economic well-being and growth potential. A general understanding of these resources and developmental trends in the area is helpful in identifying regional problems and needs, and developing appropriate solutions. The following paragraphs discuss the resources of the study region - Southeastern New Hampshire and Southern Maine - as well as their development and economy. Much information within these paragraphs has been taken from several volumes of a series published by the Southeastern New Hampshire Regional Planning Commission entitled, "Population Report and Projections," "Economic Report and Projections," "Existing Land Use," and "Future Land Use."

It should be noted at this point that the city of Portsmouth has the greatest influence on decisions about channel improvements to the Piscataqua River, and would be the most affected by such improvements. Furthermore, information is more readily available on this city than on other surrounding communities. For these reasons, discussions in the following paragraphs in many cases center primarly on the Portsmouth area.

Population and Housing

The decades between 1940 and 1960 saw the largest increase in population in Portsmouth to date. During this period, the population increased by 11,012 or 71% of the entire increase from 1900 to 1980, most of it during the 1950's. This is shown in Table 5. The construction of homes for this growing population proceed at a more sedate pace than population growth, yet 39% of the dwelling units being used in Portsmouth during 1980 were built betwen 1940 and 1950 as can be deduced from Table 6. These figures reflect both the expansion of military activity during World War II, and the population boom, and housing shortage which followed.

As can be seen in Table 7, population projections for Portsmouth show a slight decrease for the population from 1980 to 1980. This decrease is primarily due to reductions which have taken place at Pease Air Force Base.

Table 5
Population of 20th Century Portsmouth
New Hampshire (1900 to 1970)

Census Year	Population	Increase from Previous Census Year	Percent of Total Increase 1930 to 1970
1970	26,059	226	1.5
1960	25,833	7,003	45.4
1950	18,830	4,009	26.0
1940	14,821	326	2.1
1930	14,495	926	6.0
1920	13,569	2,300	14.9
1910	11,269	632	4.1
1900	10,637		
		15,422	100.0

Source: 1970 U.S. Census

Table 6
Housing in Portsmouth, New Hampshire

Time Period	Number of Dwelling Units Built	Percent of Total Units
1960 to 1970	841	10
1950 to 1960	1,914	23
1940 to 1950	1,310	16
Before 1940	4,241	51
Total	8,306	100

Table 7
Population Projections for Portsmouth, New Hampshire

Year	Estimate
1970	25,727
1980	24,030
1990	29,300
2000	34,735

Source: Demographic Projections, Southeast New Hampshire, ABT Associates, Inc.

Economy and Land Use

The port of Portsmouth is one of several small deep-draft harbors under the influence of Boston and Portland Harbors and is affected by their industrial, commerical, residential, and recreational developments. Within the port and river area is the Portsmouth Naval Shipyard, Pease Air Force Base, several petroleum receiving, shipping and handling facilities, and several bulk and general terminals. Important basic industries in the region include manufacturing, tourism, and port-related activity.

Portmsouth has a land area of about 8,109 acres, over half of which is developed. This developed land includes an urban commercial district near the harbor, other outlying commerical areas, residential areas consisting primarily of single family homes, and several industrial areas. Other major land uses in Portsmouth include transportation facilities and rights-of-way, including Pease Air Force Base, major highways, a railway, and facilities for ocean shipping. Open land uses include power easements, parks, preserves, wet lands, and cemetaries.

Portsmouth has a varied and healthy economic base which is growing at a rate the city is well able to absorb. The most visible industry is tourism. During the summer months in particular, the Portsmouth region consistently generates the highest level of visitor activity of any region in New Hampshire. Efforts have been made to preserve the atmosphere of a bustling New England seaport. Most of the downtown area and several of the older residential districts are official historical areas and are protected by municipal legislation. In 1977 the city established a historic district which includes most of the downtown area as well as older residential areas. The city planners fully recognize the value of preserving the areas in an effort to attract visitors.

The impact of these visitors has been to stimulate the city's cultural development and support many small shops and restaurants. Sixteen new restaurants were established in the city between 1970 and 1976, some of which have succeeded in establishing considerable reputation in Boston and elsewhere.

Tourism, though important, is not the only significant industry in Portsmouth. In this, Portsmouth differs from most of New England's old seaport towns, such as Provincetown and Nantucket. Though these towns were once the source of much of the regions's wealth, many of them now depend almost solely on tourism. Postsmouth Harbor, on the other hand, is still an active port, accommodating a variety of craft from oil tankers and submarines to lobster and pleasure boats.

The harbor encourages the manufacture of large and cumbersome objects by providing a relatively safe and easy method of transportation for products which would be extremely difficult and costly to transport over land. The mainstay of Portsmouth's manufacturing is, however, the type of production exemplified by the computer industry.

There are only two industrial concentrations of any significance in the southeastern New Hampshire and southern Maine regions; one along the Piscataqua River centering on the Portsmouth-Newington boundary, the other off Route 1 in Portsmouth. Smaller industrial areas, often only containing one firm, are scattered throughout the region. Projected industrial developments show the Portsmouth area as having the greatest growth potential in the region, primarily because it possesses natural and manmade attributes lacking elsewhere in the region. These include: a deep-water ocean port, direct rail and highway access, a pool of skilled labor, and, for the immediate future, ample municipal water supply, sewage and treatment facilities, natural gas, and large quantities of electricity.

Portsmouth has grown into a major retail center serving the entire New Hampshire seacoast region. Portsmouth exceeds other larger New England cities in terms of per capita sales in most major retail categories.

Employment

The generally healthy state of New Hampshire's economy is reflected in its good employment situation. Average unemployment is less than 5% in Portsmouth, despite the generally poor employment situation in the rest of New England. As can be seen in Table 8, although 26% of the employed persons in Portsmouth are employed in manufacturing, over 45% are employed in services, retail trade, and other tourist related industries. The situation is expected to continue.

Table 8
1970 Employment By Industry

Industry	Number of Employees	Percent of Total
Manufacturing	2,066	26
Transportation	127	2
Wholesale Trade	260	3
Food - Related Businesses	732	9
Retail Trade	1,163	15
Services	2,312	30
Public Administration	463	6
Other	690	9
TOTAL	7,815	100

SOURCE: 1970 U.S. Census

The labor market area for the Portsmouth region includes nine communities: Portsmouth, Hampton, Rye, North Hampton, Seabrook, Greenland, Hampton Falls, New Castle, and Newington, New Hampshire. Combined with secondary labor markets of Rochester and Exeter-Raymond, New Hampshire and Southern York County, Maine, the total labor market population for 1970 was 256,300 with Portsmouth having 11,279 employees.

The area's largest employer is the Portsmouth Shipyard of the U.S. Navy, located in Kittery, Maine. For a 9-year period prior to 1973, the shipyard had been a liability in the area's employment picture with a phasing out period scheduled to end in 1974. From an employment peak of 8,400 in 1964, shipyard employment had decline to 5,800 in 1970 with 775 workers removed from the payroll in the last quarter of 1980 alone. The situation has currently stabilized, and continued operation at the present reduced level is foreseen. No further cutbacks are anticipated.

Transportation

The region utilizes every mode of transportation in wide use in this country except passenger traffic on rails. Almost all passenger trips are made by private automobile; the remainder are by taxi, interstate bus, or airport limousine. A very few trips are by private aircraft or boat. Freight is transportated primarily by truck, although significant amounts enter by freighter through the Piscataqua River port facilities in Portsmouth and in Newington, New Hampshire, and a significant amount of rail passes through the region enroute.

One civilian airport, Hampton Airport, one military airport, Pease AFB; two through railroads, and one regional railroad owned by Boston and Maine Railroad; and a well established network of roadways including I-95 and U.S. Routes 1 and 4 are located in the region. There are 3 bridges which cross the Piscataqua River. From downstream to upstream these bridges are known as the Memorial Bridge and Maine-New Hapmshire Interstate Bridge are both the vertical lift bridges while the Route I-95 Highway Bridge is a fixed span. (Plate 1).

Riverside Development

Twenty private piers, wharves, and docks are located along the lower 4-1/2 miles of the Piscataqua River. Nineteen are along the south bank of the river, including 15 within the city limits of Portsmouth, and 4 in the town of Newington; the remaining facility is on Badgers Island, Maine, opposite downtown Portsmouth. Eight of these terminals handle deep-draft vessels. These deep-draft terminals are shown on the Project Map, Plate 1, at the end of this report. Table 9 gives a listing of the functional uses of the various piers, wharves, and docks on the Piscataqua River.

Table 9

Functional Uses of Piers, Wharfs, and Docks

Function	Number of Facilities
Cargo Handling:	
General cargo	1
Containers	1
Dry bulk commodities	1
Gypsum rock	1
Heavy lift items	1
Lobster, fish, and other seafoods	5
Petroleum products	6
Salt	1
Scrap metal	2
Wire and submarine cable	1
Bunkering	2
Fueling vessels	1
Marine repair	1
Mooring:	
Excursion boats	2
Fishing boats	6
Miscellaneous	4

In regard to new facilities, the New Hampshire State Port Authority completed the first phase of construction of its facility in 1965, including a wharf, an office building, and storage shed with 11,000 square feet of storage space. Plans for the future call for the expansion of this facility by the addition of two more wharves, a gantry crane, and refueling capacity and, at one end of the facility, a separate set of berths for commerical fishing craft.

Waterway Improvements

The existing Federal project for Portsmouth Harbor-Piscataqua River, Maine and New Hampshire is shown on the Project Map, Plate 1, at the end of this report. The existing project was adopted on 3 September 1954, and modified on 23 October 1962, and 23 December 1965 by the Chief of Engineers under Section 107 of the River and Harbor Act of 1960 as amended in 1975. A description of the improvements as of 30 September 1980 follows. All depths refer to mean low water.

The existing Federal project provides for:

- A channel 35 feet in depth and 400 feet wide with additional widths provided at the bends by the removal of ledge rock at Henderson Point, Gangway Rock, Badger's Island, the Maine-New Hampshire Interstate Bridge, and Boiling Rock. The channel extends from deep water in Portsmouth Harbor to a point about 1,700 feet above the Atlantic Terminal Sales dock in Newington, and has a 950-foot wide turning basin above Boiling Rock and an 850-foot wide turning basin at the head of the project.

- A channel 6 feet deep and 100 feet wide extending from Little Harbor through the Rye-New Castle drawbridge, and then northerly between the mainland and Leach's Island to deep water near Shapleigh Island.

- A channel 6 feet deep and 75 feet wide up Sagamore Creek with an anchorage strip of the same depth, 75 feet wide, totaling 3 acres in Sagamore Creek.

The 35-foot deep-draft channel was completed in February 1969, and construction of the small-boat channels in the Rye-New Castle area was completed in February 1971. Total cost of the new work was $5.4 million.

Waterborne Commerce

Table 10 gives a comparative statement of waterborne commerce for the years 1971 through 1975. As can be seen the total tonnage has been inceasing steadily over the years.

Table 10
Comparative Statement of Commerce

Year	Tons	Percent Increase
1971	2,174,425	0.6
1972	2,188,071	5.8
1973	2,314,900	2.1
1974	2,364,290	24.5
1975	2,943,343	6.8
1976	3,143,313	10.2
1977	3,499,854	

Table 11 gives a breakdown of waterborne commerce for the year 1977 showing petroleum products, gypsum rock, scrap metal, and salt as being the principle waterborne commodities handled at the port. It can be seen from the table that petroleum products comprise the major portion of the tonnage in the port.

Table 11
Waterborne Commerce - 1976
(Short Tons)

			Foreign	Domestic		
				Coastwise		
	Commodity	Total	Imports	Receipts	Shipments	Local
	Total	3,499,854	1,977235	1,021,729	469,647	31,243
1311	Crude Petroleum	560,894	560,894			
1411	Limestone	85,627	85,627			
1491	Salt	144,799	144,799			
2039	Prep. Fruit and Veg. Juice NEC	20	20			
2421	Lumber	503	503			
2911	Gasoline	169,411	11,262	158,148		
2912	Jet Fuel	103,536		102,472	1,064	
2913	Kerosene	81,947	34,629	47,318		
2914	Distillate Fuel Oil	890,966	157,849	644,834	57,040	31,243
2915	Residual Fuel Oil	1,263,031	824,295	64,179	374,557	
2917	Naptha, Petroleum Solvents	36,986			36,986	
2921	Liquidified Gases	157,269	157,269			
2991	Petroleum and Coal Prod. NEC	4,478		4,478		
3321	Nonferrous Metals, NEC	86	86			
3511	Machinery, Except Electrical	300		300		
4112	Commodities, NEC	1	1			

Total Ton-Miles 15,337,936

Vessel Traffic

Fully-loaded 40,000 dead weight ton (DWT) vessels having lengths of 680 feet and drafts of 37 feet are the largest vessels which have entered the Piscataqua River up to this time. These vessels are always tug assisted. The majority of the deep-draft vessels brought in, however, are in the range of 30-35,000 DWT. A breakdown of trips and drafts of vessels entering and leaving Portsmouth Harbor during 1977 is given in Table 12.

The trend in deep-draft vessels usage is to increase the carrying capacity in order to take advantage of the reduced transportation costs. Consequently, the future outlook is for increased use of the 40,000 DWT range of vesssels. Without channel improvements, the 30-35,000 DWT range will continue to dominate; however, as these vessels are continually phased out of operation, the larger vessels will be used more often, or if the risk of operating these vessels in the harbor becomes to great, users may be forced to relocate.

Table 12
Trips and Drafts of Vessels - 1977

Harbor or Waterway	DIRECTION						DIRECTION					
	Self-Propelled Vessels			Non-Self Propelled Vessels			Self-Propelled Vessels			Non-Self Propelled Vessels		
Draft (Feet)	Passenger and Dry Cargo	Tanker	Towboat or Tugboat	Dry Cargo	Tanker	TOTAL	Passenger and Dry Cargo	Tanker	Towboat or Tugboat	Dry Cargo	Tanker	TOTAL
Portsmouth Harbor, N.H.				INBOUND							OUTBOUND	
36		31			1	32						
35		16				16		1				1
34		11				11		1				1
33	3	4				7						
32		7				7		1				1
31	8	6				14						
30	2	3				5		1				1
28		4			1	5		8			4	12
27		2				2	1	2			2	5
26		6	1		2	9	1	9			5	15
25		1				1	2	11			9	22
24							1	16			4	21
23	4	1				5	3	13			2	18
22		2				2	4	9				13
21					2	2		6			1	7
20					1	1	4	11			1	10
19		1			4	5	1	1			2	4
18 and Less	168	42	92	1	51	354	166	47	97	1	35	346
TOTAL	185	139	93	1	22	475	183	137	97	1	65	493

IV. WITHOUT PROJECT PROJECTION

When examining the desirability of any proposed plan, it is necessary to have a well defined control condition for comparison. This control condition should not necessarily be the current condition since gradual non-Federal changes will impact the region over the years. Instead, the condition used for comparison should be the best possible estimate of a future scenario that accounts for all current trends in existing programs.

For Portsmouth Harbor and the Piscataqua River, the without project condition is taken to mean that the existing channel would be maintained with no additional improvements or modifications. The safety hazard would remain as a vital concern.

Waterborne commerce in Portsmouth Harbor and the Piscataqua River has been steadily increasing, and the trend in the size of the cargo vessels, especially tankers, is toward larger ships that are more economical to operate. A major portion of the existing and anticipated future deep-draft waterborne commerce on the Piscataqua is involved with the transport of petroleum products. The smaller petroleum tankers in the 15,000 to 25,000 dead weight tons (DWT) range are steadily being phased out by vessels in the 30,000 to 40,000 DWT range. Currently, the largest vessels to utilize the channel are fully loaded 40,000 DWT vessels having lengths of 680 feet and drafts of 37 feet. At the present time, only one or two of these vessels are brought in annually. Extreme care has to be taken while navigating against the current through the two vertical lift bridges and around the numerous narrow bends.

Most of the deep-draft vessels being brought in are in the 30,000-35,000 DWT range. Unless the channel improvements are made, this range of vessel size will continue to dominate future traffic flow in the harbor, and the economic gains that could be achieved by utilizing 40,000-45,000 DWT will not be utilized. In addition, the world-wide availability of 30,000-35,000 DWT vessels will decrease in the future. A shortage of vessels will force business persons to chose between using other harbors or accepting the additional risk of bringing 40,000 DWT vessel into the harbor.

At least one case exists in which business was lost at the New Hampshire State Port Authority facility because the channel could not handle larger vessels. Therefore, without the project, economic growth of the harbor area would be hampered; and, as more of the 40,000 DWT vessels are brought in, the potential for grounding or a collision that results in a catastrophic oil spill will greatly increase.

IV. PROBLEMS, NEDDS AND OPPORTUNITIES

As mentioned earlier in this report, the study area is experiencing several water and related land resource problems associated with water supply, water quality, flood damage, navigation and recreation. All of these items are being addressed by the Corps in a concurrent water resource study for southeastern New Hampshire, which includes the Piscataqua River Basin and the New Hampshire coastal area. The main emphasis in that study is being placed on water supply. In order to avoid a duplication of effort and expenditures, and due to the nature of our authorizing Resolution, this study will concern itself with deep-draft navigation problems on the Piscataqua River and will coordinate its effort with the other on-going Corps study.

The initial study findings indicated that three areas of the existing Federal channel on the Piscataqua River pose a problem to deep-draft vessel traffic. This section of the report will discuss the problems associated with these areas, the need to improve them in order to better accommodate the existing and projected future vessel fleet, and the opportunities available to resolve the problems associated with deep-draft navigation on the Piscataqua.

The major problems as defined by local interests involved with deep-draft navigation on the Piscataqua River are:

- Insufficient area in the existing turning basin to maneuver for deep-draft vessels.

- Treacherous currents that restrict vessel movements and make maneuvering difficult.

- Sharp bends bordered by ledge rock in the channel that pose a safety hazard to navigation.

- Two vertical lift bridges, the Memorial Bridge and the Maine-New Hampshire Interstate Bridge, that span the navigation channel and have to be raised each time a larger vessel passes under them.

At times these difficulties are compounded by fishing vessels and summer pleasure craft, which frequently use the channel, making the maneuvering of the larger deep-draft vessels more difficult.

The Portsmouth pilots have the responsibility of navigating the deep-draft vessels into and out of Portsmouth Harbor and the Piscataqua River. They have been very helpful in defining the problems associated with deep-draft navigation on the river and in pointing out possible solutions to them. The following paragraphs contain a discussion of the items that affect navigation on the river, and present an example of the normal operating procedures followed by the pilots in bringing in a deep-draft vessel to the Sprague Energy petroleum handling terminal which is located 1,500 feet upstream of the I-95 bridge.

The Piscataqua River is tidal in the area of the deep-draft Federal channel. The tide ranges from a maximum of about 11.0 feet above mean low water (MLW) to a minimum of 2.0 feet below MLW. The currents average about 4 to 5 knots with extremes of about 7 knots at various times. The periods of slack water in the channel last only minutes, and the current immediately goes from one direction to the other. It is extremely critical that the large vessels arrive at their destination during the period of slack water. Slack water periods are used as the base periods for the movement of deep-draft vessels on the river.

The first thing the pilots do prior to the scheduled arrival of a vessel is to determine when the appropriate period of slack water will occur; they then work backwards to arrive at the proper time to pick up the vessel at the harbor entrance. The timing is so critical that if the ship arrives even 30 minutes later than the predetermined pickup time the pilots will not bring the vessels in until the next acceptable slack water period.

Ships with drafts in excess of 27 feet cannot be safely brought in at the end of the flood tide, meaning they are brought in with the current. One of the major reasons for this is that the channel has so many sharp turns, that at these drafts the ship cannot make the turns going against the current on the last of the ebb. The farther up the channel the vessel has to go to dock, the stronger the current the vessel has to contend with upon entering the harbor. Most the terminals on the river are located beyond the two vertical lift bridges, which means in most cases when the larger vessels enter the channel they have to contend with a strong flood current. Vessels with drafts of 27 feet or less can come in during the high or low slack water. If they miss the slack tide, the delay to the next is not as long as for the larger vessels, since they can take advantage of both slack high and low water.

The following paragraphs discuss the movement of a larger deep-draft vessel from the harbor entrance to the Sprague terminal. The reference points mentioned in the discussion are shown on Plate 1.

The vessel is boarded two hours before the predetermined dock time at the anchorage area located about two miles south of the harbor entrance. After getting underway, the plan is to be at Fort Point, New Castle Island, one hour before the predetermined docking time. At that time, the tugs come alongside the vessel, in this case three tugs--two foreward on opposite sides and one aft on starboard side are used. Three tugs are necessary for the larger vessels to help negotiate the sharp turns, or to turn the vessel around if there is a problem, or to assist with any mechanical problems on the ship and last of all to help dock the vessel and hold her while lines are secured.

At about 45 minutes before docking, the pilots plan to arrive at Henderson's Point, the first bad turn, using speeds of slow and dead slow on the vessels as necessary to steer. This area is designated as AREA 3 on Plate 1. The ship must go extremely slow on all turns because tugboats are not effective while handling a fast mooring ship.

In order to make the turn in the channel around Henderson Point, a vessel must begin its turn at Sullivan Point. If the turn is begun too late, the swift current in combination with the operating speed of the vessel could force the vessel into Pierce Island. This situation is aggravated further by a back eddy which reflects off the west bank of Seavey Island at Henderson Pont and travels across the channel towards Pierce Island. If the turn is begun before Sullivan Point, the stern of the vessel could be forced into the ledge located in AREA 3.

In order to eliminate this problem, it has been suggested that this ledge forming the southerly channel limit directly across from Henderson Point be removed to provide a width of 550 feet. This would be to the advantage of all deep-draft vessels passing this point and would allow inbound loaded vessesl to begin making the turn around Henderson Point sooner, thereby assuring a safer route. It would also make the turn around Henderson Point by outbound vessels easier and safer.

As the vessel nears Henderson's Point, the pilot contact the Memorial and Interstate Bridge operators by radio to have them raise the bridges. They are still a long way off, but due to the fact they are coming in with the current, it is important to know as soon as possible if either bridge is inoperable, in order to allow enough time and room to turn the vessel and go back out. If they go beyond a certain point in approaching the Memorial Bridge, and the Interstate Bridge develops a problem, the situation could be disastrous because, under existing conditions, there is not sufficient room to turn a large ship between the two bridges. This area is labeled as AREA 1 on Plate 1.

After clearing the Memorial Bridge, the vessel must make a very sharp right turn, the worst in the channel, and during this, if it is necessary to back the ship to stop as it is turning, they will be unable to prevent the ship from turning around, as a result of the flood current. If this were to occur, the vessel would probably end up hung up fore and aft across the channel. During an average passage it is usually necessary to keep the bridges in a raised position for 20 minutes or more for safety purposes.

In order to reduce the risk of a vessel hitting the Interstate Bridge or being forced aground by the current while turning, it has been suggested that the existing turning basin be widened to a 1,000-foot wide area. This would entail the removal of ordinary material and ledge rock from the northerly channel limit directly across from the New Hampshire State Port Authority. This widening would allow loaded inbound vessels using the Port Authority dock and the Granite State Minerals dock to be safely turned before berthing. The widening would also be advantageous to all other deep-draft vessels by:

- Allowing the turning of all vessels as quickly as possible.

- Providing an area for turning in an emergency situation such as development of operational difficulties by the Interstate Bridge, vessels, or tugs or navigation problems requiring the vessel to turn for a second approach to the bridge opening.

- Allowing the use of more of the larger vessels, which are presently transiting the channel as well as a slight increase in vessel size.

- Providing an easier and safer approach to the Interstate Bridge.

It has also been suggested that 100 feet be removed from the northerly channel limit adjacent to Badgers Island. This improvement would be to the advantage of all channel users and would allow vessels to make the turn around Badgers Island without the risk of hitting ledge or being forced across the channel by cross currents during both inbound and outbound trips.

Assuming the bridges function properly, the Memorial Bridge is passed about 30 minutes before docking time. After negotiating the turn at Badgers Island, which is particularly bad, the ship must stop the sharp swing to the right and come left to go through the Interstate Bridge, which is a hazard in itself due to its angle across the river. After the ship is properly aligned and fair with the bridge, the forward tugs must release the vessel and preceed it through the bridge in order to rejoin it on the other side. The 200 foot horizontal clearance of the Interstate Bridge, which is effectively reduced by the skew of the vessel approach, is not wide enough for both the vessels and tugs to pass through at the same time.

At this time, the vessel is about 20 minutes from the dock and the current is slowing down gradually. The tugs then come back alongside the vessel and position themselves for docking, one aft and two foreward, all on the starboard side. After the ship is positioned alongside the dock, the ship lines are run out. At the Sprague Dock it is necessary to put out 17 lines, and it usually takes about one hour. The current usually begins to ebb just as the ship comes alongside the dock, and within 20 minutes it becomes a strong ebb of 3 or 4 knots. The tugs are needed to hold the ship until all the lines are secured.

The third area of concern to local interests which is not mentioned in this example, is the turning basin at the head of the Federal channel labeled as AREA 2 on Plate 1. This area is used to turn the vessels before berthing at the ATC Petroleum Dock. Under existing conditions, it is very difficult to maneuver the large vessels, especially with the flood current acting to push the vessel farther up in the channel towards shallow water. This could result in the grounding of the vessel. The results of this could prove to be catastrophic.

It has been suggested that the existing turning basin be widened to provide a 1,000-foot wide area. This would entail the removal of ordinary material and ledge rock from the northerly channel limit directly across the channel from the ATC Petroleum Dock. This widening would facilitate the turning of large vessels using the Atlantic Terminal.

As mentioned throughout this discussion, the Memorial and Interstate vertical lift bridges are considered to be potential hazards to deep-draft vessel traffic on the Piscataqua.

In the case of the Memorial Bridge, the main concern is with mechanical failure which would prevent the bridge from being raised. The horizontal clearance of 260 feet is sufficient to allow a 40,000 DWT tanker or larger to pass through with a tug on each side up forward, as well as one at the stern. Under present operating procedures, visual and radio contact is made with the bridge far enough in advance to be able to turn the vessel, and bring it back out, in case the bridge becomes inoperable. The bridge itself appears to be in good physical condition, and is well maintained. Barring any unforseen difficulties, it should continue to function effectively for several years. It appears that modification of, or to, this bridge is not necessary in order to ensure the continued safe and efficient transit of the river by deep-draft vessels. Using the same procedures currently being employed, and allowing for the continued diligence of the pilots in bringing in deep-draft vessels should be all that is necessary to guard against a collision occurring with the bridge.

The Interstate Bridge is considered to be the more critical of the two bridges becasue of its physical location on the river, close proximity to the Memorial Bridge, its effect upon the current in the river, the relatively narrow horizontal clearance of 200 feet between abutments, and the potential for mechanical failure are all items of concern to deep-draft vessel traffic on the river. As is the case with the Memorial Bridge, the major item of concern is the potential for mechanical failure of the bridge, causing it to be stuck in the down position. If this should occur when a deep-draft vessel is approaching, or passing through the Memorial Bridge, it could be catastrophic. Under existing conditions, there is not sufficient room to turn a large tanker in the maneuvering area between the two bridges. The vessel would end up wedged across the channel or colliding with the Interstate Bridge.

Due to the angle at which the Interstate crosses the Piscataqua, the current passes through it askew. This, in turn, requires that the larger vessels passing through the bridge do so at an angle, in order to keep aligned with the current and keep from being pushed to one side or the other. What this does, in effect, is reduce the horizontal clearance between the abutments to about 140 feet. The tankers in the 35,000 to 40,000 DWT range have beams of about 90 to 100 feet. When these vessels pass through the bridge, they do so with a minimal amount of horizontal clearance which may be equated to the act of threading a needle. The two tugs that are normally positioned up forward on each side of the vessel have to disengage themselves while the vessel passes through the bridge. Due to the way that the large tankers are cut away at the stern, the tug located in the stern can keep its position while the vessel passes through the bridge. Just prior to, and while the vessel is passing through the bridge, the vessel is basically operating under its own power and steerage. The physical condition and maneuverability of the vessels being brought in have to be given due consideration as a result of this situation. Even though they are smaller, the 20,000 and 30,000 DWT vessels are getting older, and they are often not as maneuverable as the larger and newer vessels in the 30,000 to 40,000 DWT range. From the point of view of maneuverability and physical condition, the larger and newer vessels are better suited for navigation on the river. The problem with these larger vessels involves the lack of adequate turning basins in which to maneuver, and the difficulties encountered by them in going around some of the sharp bends in the channel.

It has been suggested that consideration be given to modification of one, or both, of these vertical lift bridges in order to reduce the potential hazard they pose to deep-draft navigation on the river. This study will evaluate the feasibility of modifying these bridges.

Because of the physical conditions and above mentioned problem areas, the Piscataqua River is one of the most difficult to navigate on the entire

Atlantic Coast. The absence of serious accidents on the river, to date, is largely due to pilot expertise and adequate tug boat assistance. However, it is the feeling of the pilots, tugboat operators, and other channel users, that the risks involved are becoming greater each year. Portsmouth Harbor is receiving more and more tonnage each year, and the trend is to larger, more economical ships. In the case of Portsmouth, this does not mean that there will be any significant increase in the size of the vessels over that of the largest ones now being brought in. What it means is that there will be more of these larger vessels brought in over those being brought in now. The 15,000 to 25,000 DWT tankers are steadily being replaced by the 30,000 to 40,000 DWT ones. Most of the terminals on the Piscataqua have recently reached their limit as to the size of the vessel they can accommodate, with the exception of Granite State Mineral Company Pier and the New Hampshire State Pier, both of which are located between the two vertical lift bridges. These terminals have to restrict the size of the vessels they bring in to those that can be safely turned in the turning basin located adjacent to them.

Improvements to the three problem areas will reduce the risk of brinng in the larger deep-draft vessels (40,000 DWT). The ability to use these larger more economical vessesl will result in transportation costs savings which will be transfered to local consumers. If improvements are not made, transportation costs will increase becuase the smaller less efficient 20,000-35,000 DWT vessels will be the only vessels that can use the channel at an acceptable level of risk.

IV. PLANNING CONSTRAINTS

In the process of developing management measures to solve the problems and fulfill the needs identified during the course of a planning study, certain restrictions often begin to surface. These limitations can cover a wide spectrum including natural conditions existing in the study area, state of the art technological matters, and economic, environmental, social and legal restrictions.

During the course of the study, several items of concern that have played a major role in the plan formulation process have been identified. Of the items identified, there are three which proved to be major planning constraints. They are related to the issues of dredging, disposal of dredged material and deepening of the channel.

With regard to dredging, the applicable constraint relates to the timing. The dredging work will have to be restricted to certain specific times of the year in order to protect the marine environment and organisims. The second concerns an acceptable site for disposal of the dredged material. Possible methods of disposal considered include land dispoal, ocean disposal at a site east of the Isles of Shoals, and use of the material to create offshore fish habitats. The U.S. Fish and Wildlife Service has notified us that land disposal in the vicinity of a tidal basin near the N.H. Port Authority Terminal is unacceptable. Also the ocean disposal site located east of the Isle of Shoals will have to be approved by the U.S. Environmental Protection Agency.

The third planning constraint relates to the deepening of the channel. The State of Maine, Department of Environmental Protection has indicated it would be opposed to deepening of the channel, which would allow for the use of vessels greater than 45,000 DWT.

The turning basin at the head of the Federal channel in the area of the ATC Petroleum, Inc. dock is normally utilized to turn vessels prior to docking at that facility. Early in the study, local interests indicated they wanted to have the area improved. However, a determination was made that only ATC Petroleum, Inc. would derive benefits. Under existing regulations, the Federal Government cannot particpate in an improvement project that would benefit a single user. This situation will have to be resolved before Federal participation in an improvement project these can be recommended.

Another item of concern is the potential cost sharing aspects of the project under the cost sharing guidelines recommended by President Carter for water resource projects. Under the proposal, local interests would be required to pay 5 percent of the first cost of the project. In instances where the project affects more than one State, it is being proposed that the State in which the project is constructed will be the one responsible for paying the 5 percent. They, in turn, will need to get part of the money back from the other States that will be deriving benefits from the project. However, in this case, most of the actual dredging work will be done in Maine, but most of the beneficiaries are located in New Hampshire. The cost sharing aspects will have to be resolved prior to construction of any project.

V. PLANNING OBJECTIVES

Planning objectives are defined as the national, State and local, water and related land resource management needs specific to a given study area that can be addressed to enhance the national objectives of National Economic Development and Environmental Quality. Planning objectives are resource specific, rather than need specific, to avoid precluding possible responses to resource needs and provide a focus for plan formulation.

Planning objectives for this study were established after carefully analyzing the problems and needs associated with the use of water and related land resources that have been identified for the study area. The establishment of clearly defined planning objectives is beneficial in the evalution of the various plans that have been developed during the course of the study. The relative merit of each plan is heavily dependent upon the extent to which it addresses and fulfills the established planning objectives.

Based on considerations of known public concerns and anticipated "without project" conditions that have been discussed in earlier section of the report, the following planning objectives were identified for the study:

- Contribute to the continued safe and efficient movement of deep-draft commercial vessel in Portsmouth Harbor and the Piscataqua River during the period of analysis from 1985-2035.

- Contribute to a reduction in transportation costs for waterborne commerce in Portsmouth Harbor and the Piscataqua River during the period of analysis from 1985-2035.

- Contribute to maximizing the use of existing and future port facilities in conjunction with the socio-economic needs and desires of all local interests.

- Contribute to the preservation of the environmental quality of Portsmouth Harbor and the Piscataqua River by reducing the potential of oil spills in the waterway during the 1985-2035 period of analaysis.

These objectives in conjunction with the planning concerns and constraints were used to formulate the resource management alternatives that are presented in the following section.

FORMULATION OF ALTERNATIVE PLANS

FORMULATION OF PRELIMINARY PLANS

Preliminary plans are formulated through the systematic evaluation of the problems and needs of the study area and the determination of the opportunities that are available to resolve them. These plans are designed toward attain the planning objectives established for the study, while working within the framework of the planning concerns and constraints that have been identified. State and local objectives were also given paramount consideration in the formulation of alternative plans.

I. MANAGEMENT MEASURES

A broad range of management measures which are the basis for formulating alternative plans, can be identified to address the planning objectives. Management measures can generally be categorized as either structural or non-structural.

The structural measures and alternative plans that were initially evaluated during the early stage of this study involve the incremental widening of certain critical areas along the existing Federal channel. The widening would be accomplished by the dredging and removal of ordinary overburden material and bedrock in the interest of deep-draft navigation. In addition to these structural plans that were evaluated in greater detail during the second stage of the study effort, bridge replacement by itself or in conjunction with channel improvements was also addressed.

Nonstructural measures that were addressed and evaluated during the intermediate stage of the study include offshore lightering and transshipment through a nearby deep-draft port. Lightering involves the offloading of large cargo vessels, especially tankers, onto barges to transport the goods over a short distance in waters too shallow for the navigation of larger vessels. Transshipment involves bringing in a large vessel to an intermediate port where the cargo is offloaded onto barges or smaller coastal vessels. These smaller vessels then transport the cargo to the final point of destination. This is usually done due to the fact the large vessel is too big to go directly to the final port of destination.

Other non-structural measures such as traffic management, pilot regulation and the use of favorable tides were not addressed during the Stage 2 study effort. This is due to the fact that these measures have been implmented in Portsmouth Harbor.

II. PLAN FORMULATION RATIONALE

The first steps in the plan formulation process were to identify the problems and needs associated with deep-draft navigation in Portsmouth Harbor and the Piscataqua River, establish the framework of planning constraints and concerns that will have a direct impact on the study effort establish the planning objectives analyze the existing and future vessel fleet that will be utilizing the channel, and determining the potential for expansion of the existing terminal and facilities located along the river, as well as the potential for any new developments.

Most of the above mentioned information was obtained through meetings and contact with terminal operators, the Portsmouth pilots, local community representatives, and State and Federal agencies. In addition, information was obtained from reports that have been prepared by Federal, State, local and private concerns for the area.

The main emphasis in this plan formulation process was placed on developing alternative plans that would allow for the safe and efficient transit of deep-draft vessels into and out of Portsmouth Harbor and the Piscataqua River. Safety considerations were of paramount importance throughout the plan formulation process.

Based on the adverse physical conditions associated with the deep-draft Federal channel, the capability of the existing tugboat fleet, the size of the existing docks, terminals and facilities located along the channel, and their anticipated expansion, if any, it is felt that the future deep-draft vessel fleet will contain more of the larger vessels presently utilizing the channel. Therefore, the alternative plans developed in this study were formulated for an anticipated future vessel fleet in the 30,000-40,000 DWT range. Depending on the individual vessels characteristics and condition of loading, the structural measures and plans that were developed for the study may allow for the use of a light-loaded 45,000 DWT vessel.

The non-structural measures and plans that were addressed in the study were formulated in such a manner to allow for the continued economic growth of the area, while preserving its environmental quality.

III. PLANS OF OTHERS

Granite State Minerals and the New Hampshire Port Authoirty both have facilities located on the south bank of the Piscataqua River between the two vertical life bridges. Boths of these users have preliminary plans to expand their operations. These preliminary plans call for the addition of two wharves, a gantry crane and refuleing capacity. These plans are contingent upon adequate improvements being made to the channel between the two vertical lift bridges.

ANALYSIS OF PLANS CONSIDERED IN PRELIMINARY PLANNING

ANALYSIS OF PLANS CONSIDERED IN PRELIMINARY PLANNING

ANALYSIS OF PLANS CONDSIDERED IN PRELIMINARY PLANNING

During the initial stage of the study effort, the major water and related land resource problems identified were those associated with deep-draft navigation on the Piscataqua River. These problems included insufficient room in turning basins to maneuver deep-draft vessels treacherous currents that restrict vessel movements and make maneuvering difficult, sharp bends by ledge rock that are potential hazards to the safey of deep-draft vessels, and two vertical lift bridges, the Memorial and the Maine-New Hampshire Interstate Bridges, which have to be raised each time a large vessel passes under them.

The initial group of measures and plans that were developed during Stage 1 involved the widening of the maneuvering area between the two vertical lift bridges and widening of the bend in the vicinity of Goat Island. Consideration was also given to widening the maneuvering area at the head of the channel, but a determination was made early in the study that since a single-user conflict existed for this area a great deal of money and effort should not be expended in developing plans for it, until such time as this situation is resolved. These initial alternative plans were all structural in nature, and the preliminary findings indicated that it was economically and environmentally feasible to make the improvements.

During the second stage of the study, the two areas evaluated initially were looked at in more detail, and the maneuvering area at the head of the Federal project was also carried through this stage. In addition to plans associated with widening these critical areas, consideration was given to modification of the vertical lift bridges. Non-structural plans were also considered. Offshore lightering and transshipment through a nearby deep-draft port were addressed in the second stage. The following section contains a description of the alternative plans that were analyzed during the first two stages of the study effort.

I. DESCRIPTION OF PLANS

This section of the report will discuss all of the alternatives considered during the Stage II study process that meet the planning objectives.

Alternative I

This plan involves widening the existing turning basin, located between the two vertical lift bridges, from 600 to 1,000 feet. Also, this alternative includes widening the northern limit of the channel by 100 feet at the southern end of the turning basin adjacent to Badgers Island. The proposed project area is labeled as AREA 1 on Plate 1.

Alternative II

This plan involves widening AREA 1 as described in Alternative I, along with widening the southern portion of the channel at the bend in the vicinity of Goat Island, to provide a width of 550 feet. This plan involves the improvement of AREAS 1 and 3, shown on Plate 1.

Alternative III

This plan involves the improvement of AREAS 1 and 3 as discussed in Alternative II, along with widening the existing turning basin at the head of the Federal channel in the area of the ATC Petroleum Dock to provide a maneuvering area 1,000 feet wide. This plan involves improvements to AREAS 1, 2 and 3 as shown on Plate 1.

Alternative IV

This plan involves replacement of the Maine-New Hampshire vertical lift interstate bridge with a fixed high level bridge at the same location. This bridge would be similar to the existing I-95 fixed high level highway bridge that crosses the channel a little way upstream from the Interstate Bridge.

Alternative V

This alternative involves the offloading or "lightering" of cargo from a deep-draft vessel to barges or coastal tankers outside the harbor area, which then brings the product up the river to its final destination. In some cases, after the deep-draft vessel has been light loaded to a suitable draft at which it can safely navigate the river, it then can continue on up the river to the appropriate terminal to unload. In many cases, the physical conditions are such that any deep-draft vessel significantly larger than the ones that are currently being brought in would not be able to navigate the channel, even if they were light loaded to a draft that could be accommodated by the channel.

Alternative VI

This alternative involves the transshipment of cargo through a nearby deep-draft port prior to its final arrival at Portsmouth Harbor. In this case, consideration was given to bringing in a 50,000 DWT tanker to Boston Harbor, then transferring the cargo to barges or small coastal tankers. These smaller vessels would then be used to transport the cargo up to the terminals on the Piscataqua.

Alternative VII

This alternative would combine the measures considered in Alternative I and IV. It would include widening the existing turning basin located between the two vertical lift bridges and the replacement of the Maine-New Hampshire lift bridges. The new bridge would be similar to the existing I-95 fixed high level highway bridge.

Alternative VIII

This is the No Federal Action alternative, and it would mean the continuation of hazardous and limited navigation conditions. Transportation costs for vessels would remain high. Faced with this competetive disadvantage, industry could choose to move from Portsmouth and relocate at a more profitable site.

II. COMPARATIVE ASSESSMENT AND EVALUATION OF PLANS

This section of the report is an initial screening of all alternatives considered. All the alternatives previously discussed will be evaluated. Those alternatives which are worthy of further study in Stage 3 will be selected and discussed in a later section.

Alternative I

Widening the turning basin located between the two vertical lift bridges from 600 to 1,000 feet will involve the removal and disposal of 194,000 cubic yards of overburden material and 278,000 cubic yards of ledge rock. The proposed project area is shown as AREA 1 on Plate 1. This alternative has a benefit-cost ratio of 1.69 to 1; it will also improve the safety of navigating the channel, therefore, this alternative is worthly of further consideration.

Alternative II

In addition to the improvements mentioned in Alternative I, this plan would widen the southern portion of the channel at the bend in the vicinity of Goat Island from the existing 400 feet to 550 feet. This would greatly improve the safety of navigating through this hazardous part of the channel. The plan requires the removal and disposal of 228,000 cubic yards of ordinary overburden material and 305,000 cubic yards of ledge rock. This plan which will improve the safety of navigating the channel, involves the improvements of AREAS 1 and 3 as shown on Plate 1. The benefit to cost ratio is estimated to be 1.52 to 1; therefore, this alternative is worthy of further consideration.

Alternative III

In addition to the improvements described in Alternative II, this plan would widen the existing turning basin at the head of the Federal channel from 800 feet to 1,000 feet. The improvements to AREAS 1, 2 and 3, as shown on Plate 1, will involve the removal and disposal of 345,000 cubic yards of ordinary overburden material and 481,000 cubic yards of ledge rock.

Improvements made to AREA 2 under this alternative will require discussion and concurrence between OCE and this Division. For although the improvement would benefit a single user and that user has not shown any interest in cost-sharing, there are other factors that must be taken into consideration. The turning basin is located at the head of the deep-draft navigation channel and, although it will be predominantly used by a single user, it would be used by other users during times of emergency or adverse operating conditions. Also, the improvement is not considered to be a "significant increment of improvement" because the proposed improvement to AREA 2 does not involve 50 percent of the total project costs.

Along with these factors we must consider who will benefit from this improvement. Widening of the turning basin will not result in transportation cost savings to Atlantic Terminal Corporation (ATC), the single user. It will instead greatly improve the safety of maneuvering within the turning basin. The largest vessels servicing ATC have lengths of 700′± and turning these vessels in the existing 800′ turning basin requires extreme piloting skill. The slightest error could result in a catastrophic oil spill. The results of such a spill would be devastating to the coastal environment of both Maine and New Hampshire.

Therefore, due to the following facts,

- Federal interest in the area has been established by the development of the existing channel

- the Corps has a responsibility to provide safe and efficient harbors

- the actual beneficiaries of the improvement are the citizens of the area, due to the reduced risk of an oil spill

- the benefit to cost ratio is 0.97 to 1, exclusive of safety benefits

this alternative will be considered for further consideration.

Alternative IV

This plan involves replacement of the Maine-New Hampshire vertical lift interstate bridge with a fixed high level bridge at the same location. This bridge would be similar to the existing I-95 fixed high level bridge that crosses the channel a little way upstream from the Interstate Bridge. Its modification would eliminate the possibility of mechanical malfunction and would improve safety by providing adequate vertical clearance. Removal of the Maine-New Hampshire lift bridge will not result in any transportation cost savings because the size of vessels which can safely navigate the river are restricted by the turning basin (shown as AREA 1) and the bend by Goat Island (shown as AREA 3). Also the cost of replacement of the bridge will exceed $35 million which would result in a benefit to cost ratio which is nearly negligible. Furthermore, consideration must be given to traffic problems that would result, demolition problems that would hamper navigation and business and home relocation. Therefore, due to the cost and other associated problems this alternative will not be retained for further consideration.

Alternative V

This alternative involves the offloading or lightering of cargo from a deep-draft vessel to barges or coastal tankers outside the harbor area. These barges or coastal tankers will then bring the product up the river to its final destination. In some cases, after the deep-draft vessel has been light loaded its draft will enable it to continue to its original destination.

The use of lightering at Portsmouth Harbor would require a suitable site offshore where the transfer of cargo could take place. Currently, no such location exists and the cost of constructing such a site, through the use of breakwaters, would be enormous. Also, petroleum products account for 90-95 percent of all cargo that passes through the port of Portsmouth. The transfer of petroleum products would increase the risk of a possible oil spill whose environmental impacts would be devastating. Therefore, due to the increased risk of an oil spill and the fact that a suitable offshore transfer site does not exist, lightering is not a feasible alternative for Portsmouth, and it will not be retained for further consideration.

Alternative VI

This alternative calls for transshipment of cargo through a nearby deep-draft port prior to its final arrival at Portsmouth Harbor.

Due to Portsmouth's proximity to the ports of both Boston, Massachusetts and Portland, Maine, transshipment of cargo could occur through either or both of these ports. This alternative will be given further consideration. Data for determining the actual costs and benefits of this measure are difficult to obtain, however, this is the most feasible of all non-structural measures considered.

Alternative VII

This alternative combines the measures considered in Alternative I (widening of AREA 1) and Alternative IV (replacement of the Maine-New Hampshire lift bridge). The benefits associated with this measure are primarily due to the improved turning basin and would result in an average annual benefit of $1,845,000, while the cost would amount to an average annual cost of $3,750,000. The benefit to cost ratio is 0.49 to 1; therefore, this alternative is not worthy of further consideration.

Alternative VIII

This No Federal Action Alternative Plan would permit the hazardous and limited navigation conditions to continue. Transportation costs for vessels would remain high. Faced with this competitive disadvantage, industry could choose to move from Portsmouth and relocate to a more profitable site. This plan has been discussed more fully in the section describing the without project condition. It will be used as the Future without ~~base~~ condition to which all other alternatives will be measured.

III. CONCLUSIONS

Based upon the alternatives evaluated and the degree to which each attained the planning objectives within the limits of the planning constraints, the following alternatives have been selected for further evaluation:

Alternative I - Widen the turning basin between the two vertical lift bridges

Alternative II - Widen the turning basin between the two vertical lift bridges and widen the bend near Goat Island

Alternative III - Widen the turning basin between the two vertical lift bridges, widen the bend near Goat Island, and widen the turning basin at the head of navigation.

Alternative IV - The transshipment of cargo through a nearby deep-draft port.

ASSESSMENT AND EVALUATION OF DETAILED PLANS

ASSESSMENT AND EVALUATION OF DETAILED PLANS

ASSESSMENT AND EVALUATION OF DETAILED PLANS

This section presents in greater detail the results of the studies of those plans which meet one or all of the objectives of the study. The four plans with have passed the initial planning iterations are presented in this section.

PLAN A

Plan Description

This plan involves the widening of the existing turning basin located between the Memorial vertical lift bridge and the Maine-New Hampshire vertical lift bridge. The plan proposes widening this turning basin from its current 600-foot width to a 1,000-foot width. Also, this plan includes the widening of the northern limit of the channel by 100 feet, at the southern end of the turning basin adjacent to Badgers Island. The work will involve the removal and disposal of 194,000 cubic yards of ordinary overburden material and 278,000 cubic yards of ledge rock.

IMPACT ASSESSMENT

Environmental Impacts

Plan A requires that 194,000 cubic yards of overburden material and 278,000 cubic yards of ledge rock be dredged. The overburden material is primarily composed of clean sands and gravel. A bucket or clamshell dredge will be used to remove this material. Removal of ledge rock and boulders will require drilling and blasting with dynamite. By confining the nature and timing of the detonations the overall impacts will be minimized. Some mitigation measures that can be used include the use of warning charger (dynamite or pulsed electrical currents) outside the perimeter of the proposed work area to scare away any large fish schools or mobile invertebrate animals; scheduling of blasting to avoid peak periods of fish mitigation and spawning; and submerge the charges below the mud line which will buffer the pressure shock wave. It is anticipated that the amount of blasting to be performed will not result in any significant loss of fish and lobster and would not significantly affect the food web or natural productivity of the immediate area. Furthermore, no significant loss of habital area would occur as a result of the proposed blasting activity.

Potential impacts of the dredging operations on the water quality of the Piscataqua River estuary are short term only and include increased turbidity, the temporary disturbance and release to the water column of nutrients, small amounts of heavy metals, oil and grease and other potentially polluting materials in the sediment, and the minor release of hydrogen sulfide odors. The increased turbidity will be short term and minimal due to the coarse nature of the sediments. Since the sediment to be dredged is relatively clean with low levels of nutrients, heavy metals, oil and grease, relatively small amounts of these materials will be introduced into the water column during dredging. Such a release should have minimal impacts. At this time a definite disposal site has not be selected, however, there are several alternatives under considerations. These alternatives have been discussed previously and include ocean disposal at the Isle of Shoals historic dump site, land disposal at a site owned by the New Hampshire Port Authority, or the use of the material to create offshore fish habitats. A combination of these alternatives may be utilized, such as the disposal of the sand gravel at the Isle of Shoals historic dumpsite and the placement of the rock material on any of a number of rocky shoals located immediately seaward of the mouth of the Piscataqua River in 60 feet of water. Additional information concerning environmental impacts is contined in the Appendix.

Shoreline Impacts

Plan A does not result in any shoreline changes.

Socio-Economic Impacts

Short term impacts would occur while the project is under construction. Dredging operations would probably interfere with normal vessel passage in the harbor, slowing or even stopping the traffic at times. Since the passage of deep-draft vessels is governed by tidal cycles, it may be possible to minimize delays by timing blasting correctly. If not, there would be an adverse effect on firms which rely on shipping, causing temporary delays, both in goods shipped and income flows.

The long term impacts of the plan will be increased harbor safety and a reduction in transportation costs. Over the long run the project will support economic and community growth: marine-related businesses might be influenced to locate at Portsmouth. The channel improvements would allow greater usage of larger ships, resulting in fewer vessel trips for many businesses. The reduction in vessel trips would reduce the potential for accidents.

Currently dredging disposal costs are based upon disposal at sea. If land disposal of dredged material is required then the estimated costs would be subject to change.

The estimated first cost of Plan A is $14,360,000. The equivalent annual cost based on an interest rate of 7-3/8 percent with a 50-year life is $1,090,000. The annual benefit due to transportation cost savings is estimated to be $1,845,000. A detail breakdown of the costs and benefits is contined in the Appendix.

Summary of Costs

Dredging Overburden 194,000 c.y. @ $8.35		$ 1,620,000
Remove Ledge Rock 278,000 @ $35.00		9,730,000
	Subtotal	$11,350,000
Contingencies (15%)		1,710,000
	Subtotal	$13,060,000
E&D (4%)		520,000
S&A (6%)		780,000
	Total First Cost	$14,360,000

Summary of Benefits

Transportation Cost Savings (Annual)

Commodity	1985	1990	1995	2035
Crude	$ 431,200	$ 431,200	$ 431,200	$ 431,200
Distillate	493,583	491,106	522,945	536,640
Kerosone	232,932	231,752	237,534	237,534
Residual Distallate	127,008	127,008	127,008	127,008
Butane	60,982	59,122	59,901	21,319
Residual	220,392	230,760	176,076	176,076
Salt	287,350	287,350	287,350	287,350
Total	$1,853,447	$1,858,298	$1,842,014	$1,817,127

Interest Rate - 7-3/8%

Capital Recovery Factor - .07591

Annual costs and benefits are shown below.

Annual Costs	Annual Benefits	B/C Ratio	Net Benefit
$1,090,000	$1,845,000	1.69 to 1	$755,000

EVALUATION AND TRADEOFF ANALYSIS

Plan A would provide transportation cost savings by allowing users to bring in larger vessels. It would also greatly reduce the risk of an accident in the channel. The plan will provide a turning basin between the two vertical lift bridges, which is extremely important in the event that one of the bridges experiences operational difficulty. The larger turning basin will also improve conditions for navigating through the horizontal opening of the Interstate bridge. Findings to date indicte that Plan A is the most likely candidate as the NED plan.

COST APPORTIONMENT

The local government would not be responsible for the payment of any of the initial construction costs. The State would be responsible for payment of 5 percent of the inital construction cost.

PUBLIC VIEWS

Views of Federal Agencies

The U.S. Navy stated that although the improvements to AREA 1 will not benefit the shipyard it will benefit the U.S. Government vessels such as cable ships and tankers. The U.S. Fish and Wildlife Service recommended that the dredging be undertaken between mid-November and mid-March in order to minimize the impact on anadromous fish and invertebrates.

Views of Non-Federal Agencies and Others

Local users as well as various State agencies from both the State of New Hampshire and the State of Maine have voiced their approval of this alternative. Local users felt that this was the minimum amount of improvement that would be effective.

PLAN B

Plan Description

This plan involves all the improvements included in Plan A, along with widening the southern portion of the channel at the bend in the vicinity of Goat Island from its current width of 400 feet to 550 feet. The work will involve the removal and disposal of 228,000 cubic yards of ordinary overburden material, and 305,000 cubic yards of ledge rock. The plan involves the improvement of AREAS 1 and 3 shown on Plate 1.

IMPACT ASSESSMENT

Environmental Impacts

With the exception of requiring that more material will be dredged, the impacts for Plan B are the same as those stated earlier for Plan A.

Shoreline Impacts

Plan B does not result in any shoreline changes.

Socio-Economic Impacts

The short term impacts of Plan B will be the same as the short term impacts of Plan A.

The long term impacts for the most part will also be similar to Plan A, but, the removal of ledge in the vicinity of Goat Island will increase the safety of navigation around Henderson Point for the larger commercial vessels as well as the Portsmouth Naval Shipyard. Therefore, Plan B will also benefit our national defense.

As with Plan A current dredging costs are based upon disposal at sea. If land disposal of dredged material is required then the estimated costs would be subject to change.

The estimated cost of Plan B is $15,913,000. The equivalent annual cost based on an interest rate of 7-3/8 percent with a 50-year life is $1,208,000. The annual benefit, due to transportation cost savings is estimated to be $1,845,000.

Summary of Costs

Dredging Overburden 228,000 c.y. @ $8.35		$ 1,904,000
Remove Ledge Rock 305,000 @ $35.00		10,675,000
	Subtotal	$12,579,000
Contingencies (15%)		1,887,000
	Subtotal	$14,466,000
E&D (4%)		579,000
S&A (6%)		868,000
	Total First Cost	$15,913,000

Summary of Benefits

Transportation Cost Savings (Annual)

Commodity	1985	1990	1995	2035
Crude	$ 431,200	$ 431,200	$ 431,200	$ 431,200
Distillate	493,583	491,106	522,945	536,640
Kerosone	232,932	231,752	237,534	237,534
Residual Distallate	127,008	127,008	127,008	127,008
Butane	60,982	59,122	59,901	21,319
Residual	220,392	230,760	176,076	176,076
Salt	287,350	287,350	287,350	287,350
Total	$1,853,447	$1,858,298	$1,842,014	$1,817,127

Interest Rate - 7-3/8%
Capital Recovery Factor - .07591

Annual costs and benefits are shown below.

Annual Costs	Annual Benefits	B/C Ratio	Net Benefit
$1,211,000	$1,845,000	1.52	$1,634,000

EVALUATION AND TRADEOFF ANALYSIS

Like to Plan A, Plan B would also provide transportation cost savings by allowing users to bring in larger vessels. It would also greatly reduce risk of an accident in the channel. The plan will provide a turning basin between the two vertical lift bridges and will also remove the ledge in the vicinity of Goat Island. The removal of this ledge will improve the navigating conditions through the bends near Henderson Point. Overall Plan B will improve the safety of navigation to a greater extent than Plan A.

The adverse impacts of the plan are short term and are primarily associated with dredging and disposal.

COST APPORTIONMENT

The cost apportionment of Plan B will be the same as that for Plan A.

PUBLIC VIEWS

Views of Federal Agencies

The U.S. Navy stated that improvements to AREA 3 (in the vicinity of Goat Island) "would greatly benefit the shipyard," and it highly recommends the improvements be made. The U.S. Fish and Wildlife Service noted that their recommendations for Plan A should also be followed under Plan B.

Views of Non-Federal Agencies

As with Plan A local users and various State agencies from New Hampshire and Maine approve of Plan B. They feel that Plan B will greatly reduce the hazardous navigation conditions that now exist.

PLAN C

PLAN DESCRIPTION

This plan involves all of the improvements included in Plan B, along with widening the existing turning basin at the head of the channel from 800 feet to 1,000 feet. The work will involve the removal and disposal of 345,000 cubic yards of ordinary overburden material and 481,000 cubic yards of ledge rock. The plan would improve AREAS 1, 2 and 3 shown on Plate 1.

IMPACT ASSESSMENT

Environmental Impacts

With the exception of requiring that more material be dredged, the impacts for Plan C are the same as those stated earlier for Plan A.

Shoreline Impacts

Plan C does not result in any shoreline changes.

Socio-Economic Impacts

The short term impacts of Plan C will be the same as the short-term impacts of Plan A.

The long term impacts for the most part will also be similar to both Plans A and B. However, the widening of the turning basin at the head of the Federal channel will improve the maneuvering safety of the area.

Like Plan A the current dredging costs are based upon disposal at sea. If land disposal of dredged material is required, then the estimated cost would be subject to change.

The estimated cost of Plan C is $24,940,000. The equivalent annual cost based on an interest rate of 7-3/8 percent with a 50-year life is

$1,896,400. The annual benefit, due to transportation cost savings is estimated to be $1,845,000.

Summary of Costs

Dredging Overburden 345,000 c.y. @ $8.35		$ 2,881,000
Remove Ledge Rock 481,000 @ $35.00		16,835,000
	Subtotal	$19,716,000
Contingencies (15%)		2,957,000
	Subtotal	$22,673,000
E&D (4%)		907,000
S&A (6%)		2,360,000
	Total First Cost	$24,940,000

Summary of Benefits

Transportation Cost Savings (Annual)

Commodity	1985	1990	1995	2035
Crude	$ 431,200	$ 431,200	$ 431,200	$ 431,200
Distillate	493,583	491,106	522,945	536,640
Kerosone	232,932	231,752	237,534	237,534
Residual Distallate	127,008	127,008	127,008	127,008
Butane	60,982	59,122	59,901	21,319
Residual	220,392	230,760	176,076	176,076
Salt	287,350	287,350	287,350	287,350
Total	$1,853,447	$1,858,298	$1,842,014	$1,817,127

Interest Rate - 7-3/8%
Capital Recovery Factor - .07591

Annual costs and benefits are shown below.

Annual Costs	Annual Benefits	B/C Ratio	Net Benefit
$1,893,400	$1,845,000	0.97 to 1	-$48,000

EVALUATION AND TRADEOFF ANALYSIS

Like to Plan A, Plan C would also provide transportation cost savings by allowing users to bring in larger vessels. It would also greatly reduce the risk of an accident in the channel. The plan will provide a turing basin between the two vertical lift bridges and will also remove the ledge in the vicinity of Goat Island as well as widen the turning basin at the head of the Federal channel. Overall, Plan C will improve the safety of navigation to a greater extent than either Plan A or Plan B. Although the benefit to cost ratio is slightly less than 1.0 (0.97), the intangible benefits associated with the improved safety of navigation are sufficient enough to justify the plan.

The adverse impacts of the plan are short term and are primarily associated with dredging and disposal. Findings to date indicate that Plan C is the most likely candidate for the EQ Plan.

COST APPORTIONMENT

The cost apportionment of Plan C will be the same as that for Plan A.

PUBLIC VIEWS

Views of Federal Agencies

Views of Federal agencies concerning Plan C are similar to the views expressed for Plans A and B

Views of Non-Federal Agencies

As with Plans A and B, local users and various State agencies from New Hampshire and Maine approve of Plan C. The Portsmouth pilots feel that the improvements proposed in Plan C will greatly reduce the hazards to navigation.

PLAN D

Plan Description

This plan involves the transshipment of cargo through a nearby deep-draft port prior to its final arrival at Portsmouth Harbor. Due to Portsmouth's proximity to both the Port of Boston, Massachusets and the Port of Portland, Maine, both these ports will be examined as possible locations for the transshipment to take place. This plan will not reion are sufficient enough to justify the plan.

IMPACTS ASSESSMENT

Environmental Impacts

Plan D does not require any dredging or structural changes.

Shoreline Impacts

Plan D does not result in any shoreline changes.

Socio-Economic Impacts

Plan D will significantly affect navigation in that it will increase the number of vessels using the ports of Boston, Portland and Portsmouth. The additional vessels using Boston and Portland will cause travel and unloading delays to occur because these harbors are currently operating at or near current capacity. Also, once the transshipment of goods has taken place onto smaller vessels, these vessels will increase the traffic at Portsmouth Harbor, and the greater number of vessels navigating the unimproved channel will increase the risk of accidents.

The costs associated with transshipment will be borne by the users, and these costs will be passed on to their customers. The increased risk of an accident due to the increased traffic is an intangible cost, this represents an intangible adverse impact.

EVALUATION AND TRADEOFF ANALYSIS

Plan D will increase the number of vessels using the harbors at Boston, Portland and Portsmouth. The increased traffic will increase the risk of accident. The increased traffic will also increase travel and offloading delays, which will increase costs to operations.

The plan will not require any dredging at Portsmouth Harbor, therefore, no short term environmental impacts will take place.

Also, Plan D will do little to improve the overall safety of navigation in Portsmouth Harbor. Plan D is the most feasible non-structural alternative.

COST APPORTIONMENT

All costs associated with transshipment will be borne by the operators.

PUBLIC VIEWS

View of Federal Agencies

We have not received any comments from Federal agencies regarding the use of transshipment.

Views of Non-Federal Agencies

Many of the local users felt that this plan would do little to alleviate the existing problem of safety.

STUDY MANAGEMENT

STUDY MANAGEMENT

This section describes the procedures for completing the feasibility study. Work activities, public involvement and budgeting data are presented to show Stage 3 requirements.

STAGE 3 METHODOLOGY

During the final stage of the study emphasis will be on modifying, assessing and evaluating the four alternatives, Plans A through D, to produce detailed implementation plans. Design, assessment and evaluation will be more specific and well defined. All four plans will be analyzed at a comparable level of detail so that an effective choice can be made.

Problem Identification

Refinement of the problems and needs will assure that plans fully address the objective of the study. Potential navigation improvement needs of harbor users will be re-evaluated.

Formulation of Alternatives

The four alternative plans will be studied in more detail to establish the NED and EQ plans and to make changes to incorporate the desires of the public. The selection of a disposal area for the dredged material will be accomplished early in the Stage III study effort. Environmental studies to determine the suitability of the selected site will also be completed. A final detailed evaluation of the costs and benefits associated with each alternative will be conducted.

Impact Assessment

Assessment will identify, describe and, if possible, measure the impacts of the four alternative plans in greater detail. Assessments will be done according to prescribed regulations and lead eventually to the Environmental Assessment, which will be part of the final feasibility report. Currently it is not anticipated that an Environmental Impact Statement will be required.

Evaluation

This task will evaluate the impacts of the four alternative plans. Emphasis will be given to the public's preference and the evaluation to select the best plan. Contributions to NED, EQ, SWB and RD accounts will be analyzed. The "without project condition" will be updated as required to make the proper "with" and "without" analysis.

PUBLIC INVOLVEMENT FOR STAGE 3

During Stage 3 the public involvement program will focus on developing a selected plan to meet the objectives of the study. The selected plan and results of detailed alternative studies will be presented to the public for comment and to a higher authority for review and approval.

During the period leading up to final public meeting, close coordination will be maintained with agencies of the States of New Hampshire and Maine, the U.S. Fish and Wildlife Service and other Federal agencies, the city of Portsmouth, interested organizations, individuals, and special interest groups will be briefed during workshop meetings before the completion of Stage 3. These workshop meetings will provide the proper forum for the plan selection process.

CONCLUSIONS

CONCLUSIONS

The purpose of this study is to investigate alternatives for improving the safety of navigation in the existing Federal deep-draft channel in Portsmouth Harbor. Three specific sites have been noted by local users as being in need of improvement. These areas are shown below:

- Widening the turning basin between the two vertical lift bridges (AREA 1, Plate 1)

- Widening the turning basin at the head of the Federal channel (AREA 2, Plate 1)

- Removal of the ledge at the bend in the vicinity of Goat Island (AREA 3, Plate 1)

Eight alternatives were evaluated as possible methods of improving safety. Four of these alternatives were found to be feasible during the Stage 2 study effort.

The four feasible plans described in the section entitled, "Assessment and Evaluation of Detailed Plan," will be more closely examined in Stage 3. Plans A, B and C all improve safety conditions in the harbor. It should be noted that the primary difference between the three structural alternatives, Plans A, B and C, is in the degree of safety each plan provides.

Plan A provides what the local users consider the minimal amount of improvement to safety required, while Plan C provides the maximum improvement to safety of the alternatives considered. This is an important factor when it is recalled that the locals, primary purpose for requesting this study is to improve the safety of navigation within the harbor. Plan D is the only feasible non-structural plan.

A major task, to be completed early in Stage 3, is selecting the method of disposing of the dredged material. Once the method and location of disposal are selected, it is anticipated that there will be minimal impact on the environment, as the data collected to date shows the material to be dredged to be free of pollutants.

As expressed previously in this report the city of Portsmouth and the local users have indicated strong support for completion of the study. Numerous letters from Congressmen, Senators and local groups have stressed the city's desire to accelerate completion of the project.

RECOMMENDATIONS

RECOMMENDATIONS

It is recommended that the study proceed to completion. This recommendation is based on the interest of the States of Maine and New Hampshire, the city of Portsmouth and the local users, in improving the navational safety of Portsmouth Harbor.

It is further recommended that the Stage III study focus on a detailed analysis of the four alternatives, listed below, which address the planning objectives.

- Plan A - Widen the existing turning basin located between the two vertical lift bridges.

- Plan B - Widen the existing turning basin located between the two vertical lift bridges and remove ledge near the bend in the vicinity of Goat Island.

- Plan C - Widen the existing turning basin located between the two vertical lift bridges, remove ledge near the bend in the vicinity of Goat Island and widen the existing turning basin at the head of the Federal channel.

- Plan D - Transshipment of goods through the Ports of Boston, Massachusetts and Portland, Maine.

It is also recommended that the study be given high priorty due to the strong interest and support shown by the local users in reducing the risks involved with navigating within Portsmouth Harbor.

POLICY AND OTHER ISSUES

POLICY AND OTHER ISSUES

During the Stage 3 study effort four feasible alternatives for improving the conditions at Portsmouth Harbor have been determined. However, there remain several policy issues to resolve.

The first of these issues involves the primary purpose of the improvements, safety of navigation. Portsmouth Harbor, due to its swift current, numerous rocky bends and two vertical lift bridges, is one of the east coast's most difficult harbors to navigate. The fact that there has not been a serious accident is only due to the expertise of the pilots. Local interests, aware of these hazardous conditions, requested that the Corps study methods of improving the safety of the harbor.

According to Corps policy, existing damage data should be used to quantify the benefits associated with improvements to safety. However, in Portsmouth, although it is clear that safety hazards do exist, no accidents have occurred and no damage data exists. Under such conditions, i.e., awareness that a safey hazard exists, no prior accidents, therefore, no damage data, how can the benefits associated with the safety improvements be quantified?

A second issue that must be resolved concerns the proposed improvement to the turning basin located at the head of the Federal channel. The turning basin is primarily used by Atlantic Terminal Corporation; however, under the existng project this turning basin was not considered to be under the "single user" provision. Since Federal interest has been established by the existing project and the turning basin is considered to be the "head of navigation," will improvements to this area be considered in the same light as the existing project? It should be noted that if the improvements are considered under the "single user" provisions, ATC has not expressed an interest in cost sharing.

APPENDIXES

I. TECHNICAL DATA

ENVIRONMENTAL ASSESSMENT
PROPOSED NAVIGATION IMPROVEMENTS

Portsmouth Harbor and Piscataqua River
Federal Project
Portsmouth, New Hampshire-Maine

INTRODUCTION.

Description of Existing Federal Project and Historic Summary of Authorization. The Federal navigation project at Portsmouth Harbor and the Piscataqua River, Maine and New Hampshire consists of a channel 400 feet wide and 35 feet deep below Mean Low Water from naturally deep water in Portsmouth Harbor to a point about 1,700 feet upstream from the Atlantic Terminal Sales Dock in Newington; a 950 foot turning basin above Boiling rock and an 850 foot turning basin at the upstream limits of the project; a channel 100 feet wide and six feet deep at Mean Low Water from Little Harbor through the Rye-New Castle Drawbridge northerly between the mainland and Leach's Island to deep water near Shapleigh Island; and a channel 75 feet wide and six feet deep at Mean Low Water up Sagamore Creek with an anchorage six feet deep and three acres in area in Sagamore Creek. The project limits are shown in Figure 1-1.

I. PURPOSE AND NEED FOR ACTION.

1.00. At the time the present study was initiated the channel users indicated that there were three areas along the existing channel in need of immediate improvement to ensure the continued safety of the existing and projected vessel fleet. These areas, shown in Plate 1, are discussed below in the order in which they would be encountered by an inbound deep-draft vessel. Deep-draft vessels with drafts in excess of 27 feet only enter or leave the river during flood tide.

1.01. When a vessel enters the harbor and channel the first difficulty encountered is in the vicinity of Henderson Point, labeled as AREA-3 on the attached map. In order to navigate the turn in the channel around Heneron point, a vessel must begin to turn at Sullivan Point. If the turn is started too late, the swift current in combination with the operating speed of the vessel could force the vessel into Pierce Island. This situation is aggravated further by a back eddy which runs off the west bank of Seavy Island at Henderson Point and travels across the channel towards Pierce Island. If the turn is begun before Sullivan point, the stern of the vessel could be forced into the ledge located in Area 3.

1.02. In order to alleviate the problem this study is evaluating the feasibility of removing the ledge forming the southerly channel limit directly across from Henderson Point to provide a width of 550 feet. If this is done it will allow inbound loaded vessels to begin rounding Henerdson Point sooner, thereby assuring a safer route. It will also make the turn around Henderson Point by outbound vessels easier and safer.

1.03. The second problem area encountered by an inbound vessel is in the area between the Memorial Bridge and the Maine-New Hampshire Interstate Bridge, labeled as AREA 1 on the attached map. Just prior to approaching this area with a large vessel, the pilot contacts the operators of both bridges via radio in order to get them to raise the bridges. This communication takes place when the vessel is near the U.S. Naval Base, the last place it can be turned around before its approach to, and transit under, the bridges. It is considered necessary to lift both bridges simultaneously to guard against any last-minute malfunctions. The interstate bridge is required to remain in the up position for an average of 22 minutes to allow for the passage of a deep-draft vessel Once the vessel is between the bridges, manuevering becomes very difficult.

1.04. Because of the swift cross currents, the inbound vessel must be kept close to the northerly channel limit near Badgers Island in order to be properly aligned for its approach to the interstate bridge. This side of the channel is bordered by ledge rock. The vessel is then headed toward the Interstate Bridge opening at a skew of approximately 30 degress in order to keep the vessel running parallel to the current. In the event the Interstate Bridge develops operational difficulties or if for some other reason a large vessel has to turn around between the bridges during other than slack water, the probability of the vessel being forced aground or ramming the Interstate Bridge would be high. In view of the strong currents and the change in tide level a vessel that went aground in this area would strike ledge or becomed wedged between the channel limits and split open. Cargo released in this area would be quickly dispersed with no chance of recovery or containment.

1.05. In order to minimize the risk of a vessel hitting the Interstate Bridge or being forced aground by the current while turning, this study is evaluating the feasibility of widening the existing turning basin to a 1,000 feet. This will entail the removal of ordinary material and ledge rock from the northerly channel limit directly across from the New Hampshire State Port Authority. This widening would also allow loaded inbound vessels using the New Hampshire Port Authority dock and Granite State Minerals dock to be safely turned before berthing. In conjunction with the widening of this turning basin the study is also evaluatng widening the northerly portion of the channel by 100 feet adjacent to Badgers Island. This improvement would be advantageous to all channel users and would allow vessels to make the turn around Badgers Island without the risk of hitting ledge or being forced across the channel by cross currents during both inbound and outbound trips.

1.06. The third problem area encountered by an inbound vessel is at the head of the Federal channel, designated as AREA-2 on the attached map. This area is normally used to turn vessels before berthing at the Atlantic Terminal Sales Corportion. At the present time the width of the turning basin is restrictive making maneuvering in the area very difficult and hazardous. The potential for a grounding to occur resulting in extensive physical and environmental damage is significant.

1.07. Early in the study consideration was given to widening the area to provide a 1,000-foot width. This would entail removal of ordinary material and ledge rock from the northerly channel limits directly across from the Atlantic Terminal Sales Corporation. However, detailed quantity and costs estimates were not developed for AREA-2 during Stage I of the study effort due to the fact a determination was made early in the study that a single user situation exists for AREA-2. Under existing regulations no Federal participation can be recommended or a project that is expected to be for the exclusive use of vessels serving one industry or firm. During Stage II preliminary quantity and cost estimates have been developed for AREA-2 in order to get a feel for whether or not there is any economic justification for improving the area.

1.08 Dredging and Disposal Operations.

1.09. The dredging will be performed under a private contract with the Government. The following table gives a breakdown of the quantity of ordinary overburden material and ledge rock that would need to be removed from AREAS 1, 2, and 3 in order to provide the improvements described above.

QUANTITY ESTIMATES

AREA	ORDINARY MATERIAL CUBIC YARDS (predominantly glacial till)	LEDGE ROCK CUBIC YARDS	TOTAL CUBIC YARDS
1	194,000	278,000	472,000
*2	117,000	176,000	293,000
3	34,000	27,000	61,000

*These preliminary figures are based on an assumed breakdown of 60% ledge and 40% ordinary material.

1.10. A bucket or clamshell dredge and associated sea going dump barge will be employed. It is contemplated that disposal of the dredged material will be made at two separate locations. The rock material, it is felt, can be deposited on any one of a number of rocky shoal bars found immediately seaward of the mouth of the Piscataqua River and Gerrish Island. The shoals lie within the sixty foot depth contour. The placement of additional rock material could produce an underwater reef system which would provide habitat for lobster, fish and a variety of invertebrate organisms which would attach themselves to the hard surfaces. Ideally the location for a rock reef should be where the bottom consists of compacted sands or gravel, strong enough to take the new load. Mud bottom or mobile sand areas should be avoided. It is proposed that the remainder of the material consisting principally of sandy gravel be disposed of at the Isles of Shoals dump ground.

1.11 Although consideration of off-shore disposal has concentrated to date on the Isles of Shoals and coastal waters we wish not to limit our search for disposal sites to that area. Other site identification for disposal purposes are encouraged as is productive use of the material which is suitable for construction fill.

II. ALTERNATIVES INCLUDING THE PROPOSED ACTION

2.00 No action.

2.01 Adverse Aspects of No Action. The "no action" alternative would have several effects, both direct and indirect. This alternative would ensure continuation of hazardous navigation conditions and high overhead costs of vessel operations. Present operating costs for existing vessels would either remain at current levels or would increase. These costs do not compare favorably with operating expenses of newer larger vessels. Other better developed ports may have to be used to receive and distribute products transported by the newer larger vessels. Industries currently based in Portsmouth could choose to relocate to these better areas. The "no action" alternative could also fix a ceiling level on the potential volume of incoming raw materials and, as the existing vessel fleet becomes old and obsolete, safe navigation of the river would become a more exacting task.

2.02 Beneficial Aspects of No Action. The expected environmental impact of the dredging project is minimal, therefore there are no significant beneficial environmental aspects to this alternative.

2.03 Rejection Reasoning of No Action. The potential adverse impacts of the "no action" alternative are greater than the beneficial aspects in terms of overall public interest.

2.04 Incremental Widening. The plans for widening of designated areas, shown in Figure 1 are considered to be more suitable alternatives. These include three combinations any one of which would serve to increase the safety margin provide for vessels up to 45,000 DWT to transit the channel. Existing restrictions, such as bridge clearances, rapid currents and hard bottom material cancel economic advantage to any plans to provide greater channel depths and widths than the existing ones other than in the proposed improvement areas.

2.05 Alternative Dredging Methods. Means of dredging considered were bucket and scow and hydraulic. The use of hydraulic pipeline dredging may be suitable for specific sections of the project where on-land disposal is accessible within a short distance. Hydraulic dredging may be impaired because of the difficulty in safely anchoring long pipelines in the strong tidal currents of the project.

2.06 Disposal Options. Bulk chemical and physical data of the sediments would indicate the suitability of the spoil material for various disposal alternatives. The available data, namely size distribution and visual classification, does show that these sediments would be useful as fill or construction material. Historically, dredge spoil in this project has been used by New England Tank and the New Hampshire Port Authority. Both of these concerns are willing to take the dredge spoil for use as fill material. (24), (25).

2.07 New England Tank Industries has plans to expand their facility back from the waterfront. They can accept more than 70,000 cubic yards for use on up to 100 acres of their land along the river and have offered their property for disposal purposes. This site was recently utilized (1979) for the disposal of 35,000 c.y. from maintenance dredging of the Federal project.

2.08 The New Hampshire Port Authority is willing to accept up to 300,000 cubic yards to fill in a mud flat. This plan has the conditional approval of the New Hampshire authorities subject to final engineering review. The project schedule indicates the spoil could not be accepted until 1979-80. A feasibility study for the Southeastern New Hampshire Regional Planning Commission suggested that additional berthing facilities be constructed to reduce delays and increase capacity at the present location. Utilization of the Port Authority site for disposal of dredge material will result in the permanent loss of approximately nine acres of intertidal bottom habitat and shoreline and its associated fauna and flora. This is based on the assumption that the Port Authority proceed with its plans for expansion of its existing facilities and completely fils for basin.

2.09 There are also tentative plans to fill in a 10 acre tidal basin area between Market Street and Cutts Avenue and the Boston and Maine railroad tracks. There is both local and Federal regulatory agency opposition to the filling in of this tidal estuarine area (F&WS).

2.10 Alternative Ocean Disposal Site - Portland, Maine. Fishermen have suggested an area located at 43° 34'06"N, 70° 02'W for disposal of dredged materials from the proposed maintenance of the Portland Harbor Federal navigation project. Environmental background information regarding the site is discussed in detail in the Draft Environmental Impact Statement (EIS) filed with CEQ on 11 February 1977. A Draft Supplement EIS issued March 1979, and the Final EIS dated June 1979. The U.S. Environmental Protection agency is currently preparing an Environmental Impact statement for the disposal site prior to making a determination in its designation as a regional dredged material disposal grounds.

2.11 Sediment corings, side-scan sonar mapping, benthic sampling and current measurements have been completed at this site and monitoring continuing of the on-going maintenance dredging.

2.12 Although this site may (or may not) be specifically suitable for disposal of the Portsmouth Harbor/Piscataqua River dredge spoil, excessive transportation costs make it an unrealistic site for consideration.

2.13 Disposal Site - Isles of Shoals. The historical disposal area for Portsmouth harbor dredge spoils had been the Isles of Shoals dumping ground centered about three nautical miles east of the Isles of Shoals. Sediment distribution for this area is found also in the Portsmouth Shipyard Dredging Study, (Navy) and the predominant bottom material is sand and gravel. Drifter studies were also performed on the currents near the Isles of Shoals and the net drifter patterns are westerly and southerly. These drift patterns are indicative of the circulatory tidal currents within the Gulf of Maine.

2.14 The waters surrounding the Isles of Shoals are clear, deep, and relatively pollution free. They support a rich abundance of aquatic life and form the basic trophic level in the food web upon which the commercially and recreationally important finfish and shellfish industries depend.

The Isles have traditionally supported an early winter herring fishery, as well as a shrimp fishery. The State of Maine has closed the shrimp fishery due to the declining shrimp populations. Lobsters, gray sole, and various bottom-dwelling fishes are also important to the local fisheries.

2.15 The Isles of Shoals are considered highly sensitive biological areas. A wide diversity of organisms have been observed and identified, including 256 invertebrate species, 139 algae species, 49 fish species, and 145 bird species, as well as mammal species, namely, whales and harbor seals. Adult and young harbor seals frequent the Isles in early spring; whales have been observed on the eastern side of the island during migration. Baseline environmental data on the disposal site is contained in Damos Annual Data Monitoring Report - 1978 Appendix B.

III. ENVIRONMENTAL CONSEQUENCES

3.00 Harbor Sediments. Surface grab samples were taken by the Corps of Engineers in early 1977 and 1979 and the preliminary classifications of the harbor sediments, based on visual determinations, are found in Appendix A. The sediments within the project area are mostly sands and gravels. All the samples consisting mainly of gravel also contained algae growth and exhibited a marine odor. The algae and odors may be due to the influence of the municipal and industrial discharges along the estuary which keep the nutrient levels sufficiently high enough to stimulate algae growth.

3.01 Gravel deposits will be characteristic of a high energy or, in the Portsmouth Harbor, high current velocity areas. Pockets of silt, fine sands and mud have been observed along the sides of the navigation channel just offshore of the Newington Generating Station. (5) The predominant feature of this estuary is the rocky foundation of the channel which does provide natural catch pockets for the finer sediments. Massive bedrock outcroppings are typical of the estuary. (12)

3.02 A grain size analysis was performed on the Portsmouth Harbor sediments in March 1971 and the gradation curves show that most of these grabs were of medium sand to gravel in content.

3.03 In 1976 another study looked at the sedimentation within the pier basins of the Portsmouth Naval Shipyard. Even though the grain size analysis on these sediments is indicative of the harbor sediments the chemical analysis on these sediments cannot be extrapolated to the harbor sediments. The levels of copper, lead and zinc are extremely high within the sediments of the shipyard and most likely are the result of many years of shipyard activities such as hull scraping and painting, engine overhauling and drydock activities. Elutriate tests were run on these sediments using ocean water from the Isle of Shoals dumping grounds and the copper, chromium and zinc releases were significant. The data from this report therefore only applies to side channel pier basins in Portsmouth harbor and the chemical composition of these sediments can only be applicable to a naval maintenance facility.

3.04 Dredging. It is intended that a clamshell bucket dredge will be used in the Piscataqua River estuary. The dredged material will be loaded on scows for disposal at nearby land sites or at an approved ocean dump site.

3.05 Potential impacts of dredging operations with a clamshell bucket on the water quality of the Piscataqua River estuary are short-term only and include increased turbidity, the temporary disturbance and release to the water column of nutrients, heavy metals, oil and grease, and other potentially polluting materials in the sediment, and the minor release of hydrogen sulfide odors.

3.06 The increased turbidity will be short-term and minimal due to the coarse nature of the sediments and the dispersive nature of the strong currents in the estuary. Because the currents in the Piscataqua River are strong, the turbid plume will probably be carried beyond the immediate vicinity of the dredging action.

3.07 Temporary dissolved oxygen reduction may occur in the surrounding waters during dredging due to the suspension of organic detritus, fecal pellets, and other natural organic compounds. This reduction is likely to be minimal and short-term due to the high current flow and good mixing in the project area.

3.08 Since the sediment to be dredged is relatively clean with presumably low levels of nutrients, heavy metals, oil and grease, and other potentially polluting materials, relatively small amounts of these materials will be introduced into the water column during dredging. Such a release should have minimal impact.

3.09 Finfish and the larger macro-invertebrates such as crabs can avoid unfavorable turbidity. But, larvae and juveniles may be less able to flee the area and be more susceptible to turbidity effects and smothering. A study of dredging and dredge disposal in Chesapeake Bay revealed no difference in the abundance and distribution of adult fish and fish larvae in areas contiguous to dredge and disposal areas. Also, fish placed in cages at the dredging site had the same mortality as control fish. (16) Ingle (17) demonstrated that a suspension of dredged solid materials caused mortality to fish in a laboratory test, but could not ascertain any mortality during an actual dredging situation. Because of the intermittent nature of normal dredging operations and disposal, and the high dilution available in almost any open water operation, it is generally improper to apply water quality criteria based on chronic continuous exposure to normal dredge and disposal operations.

3.10 Sherk (18) suggested that the lack of correlation between suspended solid studies and biological changes may result from the fact that the biological response is due to the shape, size, density or number of particles rather than the concentration of suspended solids. In addition, surface coatings and sorptive properties may also be more important than concentrations. It was concluded that concentration standards may be insignificant from the standpoint of assessing biological effects of suspended solids.

3.11 Dredging may also release nutrients in the sediments to the water column. These nutrients could result in a phytoplankton bloom, but decreased light transmittance due to turbidity and the smothering of benthic algae would act to decrease photosynthesis. The effects of nutrients and turbidity on phytoplankton are usually temporary and entirely local. The areas affected by dredging and spoil disposal are a small part of widely distributed populations.

3.12 It is possible that heavy metals in sediments could be released to the water column during dredging. But, the physical, chemical and biological processes involved are complex and poorly understood. Some evidence has been presented that heavy metals will not be released when anaerobic sediments are suspended but, rather metals in the water column are stripped by absorption to sediment particles. (19) It has been shown that the amount of transfer of chemical constituents from sediments to the water column is not dependent for the concentrations in the sediments as determined by bulk analysis, in any simple discernible manner. (20) Many marine organisms have been shown to concentrate heavy metals, especially filter feeders and organisms near the top of food chains. Oysters, hard clams, and soft shell clams can accumulate heavy metals against a concentration gradient. (21) Studies have shown a correlation between cadmium concentrations in tissues of fish species and the proportions of crustaceans in their diet. (21) Heavy metals are generally more toxic and damaging to the early life stages of aquatic organisms. Oyster larvae are know to be killed at low concentrations of mercury, copper, and zinc. Arsenic and chromium were found to be considerably less toxic. (22) The concentration of metals in polychaetes collected from two different areas did not reflect the differences in the metal content in the sediments. (23) Trace metals in the sediments may not be chemically available to organisms in many situations, and especially in cases where coarse sediments are involved such as with the proposed dredging action.

3.13 Blasting Impacts. Removal of ledge rock and boulders would require drilling and blasting with dynamite. The lethality of an explosive is directly related to its detonation velocity, charge weight and density of material to be blasted. Most explosive in a rock or clay substrate produces low level over pressures with, subsequent reduced laterical or vertical pressure charger. The confined nature and timing of the detonation will aid minimizing the overall impacts. Some mitigation measures that can be used include the use of warning charger (dynamite or pulsed electrical currents) outside the perimeter of the proposed work area to scare away any large fish schools or mobile invertebrate animals; scheduling of blasting to avoid peak periods of fish mitigation and spawning; and submerge the charges below the mud line which will buffer the pressure shock wave.

3.14. It is anticipated that the amount of blasting to be performed will not result in any significant loss of fish and lobster and would not significantly affect the food web or natural productivity of the immediate area. Further, no significant loss of habital area would occur as a result of the proposed blasting activity.

3.15 Disposal of Dredged Material. The sediments of the Isles of Shoals dumping ground are composed mainly of rock outcrops and sands and gravels. They are compatible with the dredge materials from Portsmouth Harbor which are mainly composed of relatively clean sands, gravels, and cobble. The sandy surface will become less attractive to deposit feeders unless amphipod colonization takes place. Any cobbles on the surface of the spoil will be available for colonization by barnacles and other epifauna.

The EPA 103 Ocean Disposal and 404 Guidelines (Jan. 1977 and Sept. 1979 Fed. Register) require that consideration be given to preventing or minimizing degradation of existing water uses at proposed disposal sites. The specific objectives are to avoid disposal which:

1. Significantly disrupt chemical, physical and biological aspects of an aquatic ecosystem.

2. Significantly disrupt the food chain including alterations or decreases in diversity of plant and animal species.

3. Inhibit movement of fauna into, within, and out of feeding, spawning, breeding and nursery areas.

4. Degrade water quality.

Disposal should be minimized wherein this activity results in:

1. Degradation of esthetic, recreational or economic values.

2. Adverse turbidity.

3.16 The Ecological Evaluation of Proposed Discharge of Dredged Material into Ocean Waters, issued jointly by EPA/COE outlines the bioassay test procedures that must be followed, except in specific cases. These test methods establish a 10 day mortality or survival basis for determining the suitability of disposal at the selected site. This mortality/survival end point does not address the more subtle, acute effects on breeding, spawning, behavior or feeding which may have more substantial impact on the long-term survival of the indicator species. Additionally, this methodology does not address the likelihood of biomagnification through the food chain which is initiated at sub-lethal concentrations in organisms at the bottom of the food chain.

The Corps of Engineers' grab samples show that the sediments in the project area are composed mainly of sand and gravel, typical of the high energy areas within the project. Such sediments are excluded at the discretion of the District Engineer from the bioassay test requirements dictated by Section 103, PL 92-532.

3.17 Disposal of the dredge spoil should be made at a site which has a similar substrate type. This is the reason for attempting to place the rock excavated on a rocky shoal. Disposal in a like-sediment area would minimize the dislocation and/or mortality of bottom dwelling organisms, thus reducing the physical impacts of disposal to burial of bottom dwelling biota. The bulk analysis results for the dredge material, indicate that there will be little or no short-term or long-term chemical or water quality impacts on the disposal site.

3.18 Disposal of the spoils at the Shoals dumpsite may be opposed by many groups because of the biological sensitivity of the area and the fact that the waters surrounding the islands are proposed Federal natural areas.

3.19 Beneficial Effects. The Piscataqua River and Portsmouth Harbor are of great importance to the local economy. Maintaining existing channels at authorized dimensions is critical to the health of the regional economy.

3.20 Related Effects. The use of dredged spoil to expand the New England Tank Industries site will provide for additional fuel storage capacity to support additional growth or sustain present economic activity. Using the spoil for fill at the New Hampshire Port Authority would allow for the expansion of the area's cargo handling capability. This is consistent with the NHPA goals of providing added shipping capacity to meet expected regional needs.

3.21 Mitigation Considerations. To minimize the effects on fish spawning dredging should be done after 30 September or in very early spring.

3.22 Dredging in the fall will avoid the spring-summer spawning runs of alewives and the summer spawning time of soft-shell clams. Also, most waterfowl and shorebirds will nest in the spring and summer. Coordination with local fishery interest in the selection of a location for disposal of the rock material will also minimize impacts to both lobster and trawl fisheries.

IV. AFFECTED ENVIRONMENT

4.00 Trends in the Utilization of Portsmouth Harbor. Portsmouth Harbor has shown a gradual rise in waterborne commerce handled from 1973 to 1975. The port is the main distribution point for heating fuels and gasoline for the entire State of New Hampshire. The port also serves as a regional distribution point for fuels for the rest of New England. Commodity traffic in crushed stone, scrap steel, and wire cable should continue to increase slowly. There have been problems in bulk shipment handling at the New Hampshire Port Authority Facility due to limited space.

4.01 Recreational boating facilities along the Maine shore are operating near or at capacity. The Southern Maine-New Hampshire coast has been experiencing continued demand for the area's recreational resources.

4.02 The Navy recently dredged an area behind Seavey Island to accommodate larger submarines. Naval ship traffic should remain basically at existing levels.

4.03 Marine Facilities. Portsmouth Harbor serves three basic functions, it is a major commercial port, it serves as an important recreational boating facility, and it is a major U.S. Navy facility.

4.04 The Harbor is at the mouth of the Piscataqua River and is the approach to the cities of Portsmouth and Dover, and the towns of New Castle, Kittery, Newmarket, Durham, Newington, and Exeter. Several U.S. Naval activities, including the Portsmouth Naval Shipyard and a regional medical clinic are located on Seavey Island at Kittery. The main channel from the mouth to Newington has a controlling depth of 35 feet. All except one of the waterfront facilities at the port are on the south bank along the lower 4-1/2 mile of the river.

4.05 The 1975 freight traffic through the port was 2,943,343 short tons. Major commodities handled include petroleum products, gypsum rock, steel cable, scrap metal, lobsters, and salt.

4.06 The port has 20 piers, wharves, and docks. Fifteen are located within the city limits of Portsmouth. The major port facilities and commodities handled are noted in Table 4-1.

4.07 As noted earlier, the port has considerable traffic in both fish and shellfish. The following is a list of fish and lobster docks in Portsmouth:

Geno's Lobster Pound Dock
LaCava Dock
Marconi's Wharf
City Landing
Portsmouth Fish & Lobster Co.
Shipyard Lobster Wharf

The port handled 73 short tons in fish in 1975. Shellfish landings are considerable, when one considers that Kittery, in addition to Portsmouth, also has large lobstering operations. Portsmouth Harbor has two excursion boat facilities located at the Viking Wharf and Barker Dock.

4.08 There are four oil handling facilities in the port. Table 4-2 gives the name of the facilities and their storage capacity.

4.09 General cargo at the port is usually handled to and from vessels by ships' tackle. Two diesel crawler cranes, capable of 20 ton lifts, when working in tandem are available at the Granite State Dock. There are no facilities in the port for extensive large ship repair. The Barton Machine Shop on Badger's Island makes repairs in fishing and recreational vessels. The Portsmouth Navigation Corporation serves the port with four towboats with capacities up to 1600 horsespower.

TABLE 4-1

MAJOR FACILITIES AND COMMODITIES HANDLED IN PORTSMOUTH HARBOR,

MAINE - NEW HAMPSHIRE

Portsmouth Naval Shipyard -	Build and repair naval craft
New Hampshire Port Authority -	General and bulk materials
National Gypsum	Crushed rock
Northeast Petroleum -	#2 fuel oil and kerosene
Mobil Oil -	Fuel oil and gasoline
C.H. Sprague & Son -	Heavy industrial oils-#6 & #4
Simplex Wire & Cable -	Underwater cable - manufacture & repair
N.E. Tank Industries -	J. P., #4 Aviation gas
Gulf Oil -	#2 kerosene
Union Oil -	#2 kerosene
Sea 3 -	Liquid propane
Atlantic Terminal Sales -	Import crude oil, #2, kerosene export #4, naptha, #6 - refining

TABLE 4-2

OIL HANDLING FACILITIES

PORTSMOUTH HARBOR, MAINE-NEW HAMPSHIRE[4]

	Storage Tanks (#)	Capacity (barrels)
Northeast Petroleum Corp.	5	197,600
Mobil Oil	14	550,000
Atlantic Terminal Corp.	6	577,000
Atlantic Terminal Corp.	12	358,000
TOTAL	37	1,682,600

4.10 Recreational Boating. As noted earlier, the harbor handles a considerable amount of recreational boating. The vast majority of this boating is accommodated at New Castle and Kittery.

4.11 It is apparent that Portsmouth Harbor plays a critical role in the commercial and recreational elements of the region. The port provides an important source of jobs and taxes and attracts industries to the area who rely on waterborne commerce.

4.12 Hydrology. The Piscataqua River is formed by the confluence of the Cocheco and Salmon Falls Rivers and flows southeasterly for 13 miles until it enters the ocean at Portsmouth Harbor. The entire 13 miles of river is tidal. Approximately nine miles from its mouth the Piscataqua receives the flow from the Great Bay tidal basin of approximately 6,200 acres and its associated six tributaries. (2) The Salmon Falls and Piscataqua Rivers form a natural boundary line for the States of New Hampshire and Maine.

4.13 The Piscataqua River and the lower Portsmouth Harbor, through which the extensive tidal basin of Great Bay are funneled, is one of the fastest flowing tidal waterways of any commercial port in the northeastern United States. (3) Due to abrupt channel changes and the strengths of flood and ebb currents, hazardous cross-currents and eddies are found in the main channel passing north and east of Pierce and New Castle Islands. The currents are so strong in this area that it would be difficult for any large draft vessel to make the swing without the assistance of a tug. (4) Tidal current data is available for the Piscataqua River in the vicinity of Portsmouth and the data for the average maximum currents are found in Table 4. The currents in the back channels are relatively weaker than the currents in the main harbor. The average current velocity at full strength in the main harbor varies from about 2.6 to 4.0 knots, whereas in the back channels the velocity varies from less than one to two knots. (3) In addition, winds from the southerly quadrants will cause a severe tidal rip at the main harbor entrance, between New Castle Island and Wood Island; at the strength of the ebb tide.

4.14 Ecological studies on the Piscataqua estuary performed in 1970 have determined that the water column is well-mixed throughout the estuary with generally less than a 2^{o}C temperature variation occurring between the surface and water 30 feet deep. (5) Salinity data also indicate that the estuary is fairly well-mixed once spring runoff has subsided. Specifically, in the upper estuary salinities were low during the spring runoff, but as the runoff decreased salinities went up. In June salinities rose to greater than 21 parts per thousand (%) and in July to greater than 28 percent. The well mixed feature of this estuary is a result of the combination of strong tidal currents and relatively narrow harbor channel which disrupts the thermal or saline stratification.

4.15 The tide at Portsmouth is semidiurnal. The average tidal range for Portsmouth Harbor is 8.4 feet. The average mean spring range is 9.7 feet and the average mean tide level is 4.2 feet. Where the Piscataqua meets the Cocheco and Salmon Falls Rivers the mean tidal range decreases to 6.6 feet.

4.16 Turbidity data is limited for Portsmouth Harbor but depth of visibility studies were performed in 1971. They found the depth of visibility was highest in the harbor and progressed to a lower visibility range in the upper estuary. Readings were generally higher on flood tide. The lowest visibility occurred during spring and increased during summer and fall as the spring runoff subsided.

4.17 Since the Piscataqua is considered the tidal portion of the Cocheco and Salmon Falls Rivers and receives freshwater inflow from the six major tributaries leading into the Great Bay, the freshwater discharge of the Piscataqua can only be calculated by totaling all the freshwater discharges of all the tributaries leading into the tidal Piscataqua. Water Resources Data for New Hampshire and Maine list the yearly discharges for the major tributaries entering the tidal Piscataqua and a typical listing illustrated in Table 2-8. Freshwater discharges from the Cocheco River are not monitored by the United States Geological Survey (USGS) and, thereby, are not included in the summary.

4.18 Water Quality. New Hampshire and Maine have an agreement to maintain acceptable water quality in the Piscataqua River by regulating their effluent discharges of the river. The river is designated by the State of New Hampshire as a Class B stream segment and by the State of Maine as Class SB-1. (6), (7), (8), (9)

4.19 New Hampshire Class B waters are acceptable for bathing, other recreational purposes, fish habitat and public water supply after adequate treatment. Maine Class SB-1 waters are suitable for all clean water usages including water contact recreation, fishing, shellfish harvesting and propagation, and fish and wildlife habitat.

4.20 There are a number of municipal and industrial discharges to the Piscataqua River from both New Hampshire and Maine. These are summarized in Tables 4- and 4-. The three generating stations of Public Service Co. of New Hampshire, (Schiller, Newington, and Daniel Street) account for 99.9 percent of the total flow for industrial sources entering the river from the New Hampshire side. (6)

4.21 The most recent water quality data was collected by the State of New Hampshire Water Supply and Pollution Control Commission in 1976. (10) Dissolved oxygen values ranged from 6.7 - 10.1 mg/l throughout the tide-waters of the Piscataqua River, exceeding the Maine Class SB-1 standards of 6.0 mg/l and within the New Hampshire Class B standards (near saturation at all times). pH values ranged from 7.5-8.1 throughout the sampling period. Maine Class SB-1 standards (6.5-8.0) were exceeded only once during the sampling program. Combined nitrate and nitrite concentrations ranged from 0.04 to 0.50 mg/l, which were well below the EPA standard of 10 mg/l nitrate nitrogen for domestic water supply. (11) Ammonia (NH_3) concentrations in the range of <0.10 to 0.22 mg/l consistently exceeded the EPA standard of 0.02 mg/l (as un-ionized ammonia (NH_3)) for freshwater aquatic life. (11) Total phosphorus values exceeded only once the EPA desired goal of 0.10 mg/l in streams or other flowing waters not discharging directly to lakes or impoundments.

4.22 In addition, the New Hampshire Water Supply and Pollution Control Commission (10) reported that coliform counts varies from location to location throughout the Piscataqua River Estuary and Portsmouth Harbor. In general, the estuary as well as Sagamore Creek showed coliform counts in the range of 0 to 70 MPN. The State of Maine has set limits of 70 and 240 colonies per 100 millileters for shellfish and non-shellfish growing areas respectively in Class SB-1 waters. The State of New Hampshire states that Class B waters shall contain not more than 240 coliform bacteria per 100 milliliters.

4.23 In summary, the Piscataqua estuary near the project area of Portsmouth Harbor has a good water quality except for two localized areas in which the coliform counts exceeded New Hampshire standards. Even though there is much industrialization centered around the project area and there is considerable industrial discharge to the Piscataqua, the water quality remains good primarily because of the great tidal exchanges between the estuary and the Atlantic Ocean. This strong semidiurnal exchange has the effect of diluting the pollutant loadings to the point where the water quality is within the New Hampshire and Maine standards.

4.24 Salt Marshes. The extent of salt marshes in New Hampshire is approximately 7500 acres, primarily in Seabrook, Hampton, Hampton Falls, and Rye. Other areas of tidal marsh habitats are spread throughout Great Bay and its associated waters. There are bands of salt marshes along the Piscataqua River in Little Harbor, and Sagamore Creek. (12)

4.25 While a formal survey of the marsh areas was not conducted, plant zones can be described as they are determined by the amount of tidal flooding. Beyond the upland edge of the marsh, on shores with a gradual slope a shrub border develops. This border is absent on steep slopes where the upland forest may overhang the marsh. Bordering the upland edge of the marsh, generally about 0.5m above the marsh on a peaty substratum is the *Panicum virgatum* (panic grass) community, a tussock grassland.

Along the seaward edge of the marsh and bordering the ditches and streams where tidal flooding occurs with every high tide, a band of Spartina alterniflora (saltwater cord grass) is found and is readily recognized by the greater height of the grass than the neighboring communities. Between these two communities is a band of dense grassland consisting of Juncus gerardi (black grass) on the higher elevations and Spartina Patens (saltmeadow grass) on the lower elevations. Within these zones are found many depressions or varied sizes and depths. The depressions are shallow and irregularly flooded by tides, the water slowly evaporates resulting in a marked increase in soil salinity. Such areas are termed salt pannes and are either bare or colonized by Salicornia europaea (glasswort) and S. virginica (woody glasswort). In circular bands around the pannes proceeding outwards are found bands of stunted S. alterniflora, then forbs, then the normal community for the area. When the depression is deep and contains water permanently, Ruppia maritima (pondweed) often colonizes it.

4.26 Finfish. The Piscataqua River and Great Bay estuary provide habitats for a variety of organisms. The rich variety of foods which include isopods, amphipods, and polychaetes, as well as the salt marshes which line the coastal areas, provide favorable conditions for survival. Figure 4- identifies important fishery areas. Thirty-four species were found to inhabit the Piscataqua River and Great Bay during a study for the Newington Generating Station 5.

4.27 Abundant resident fishes include silverside (Menidia menidia), winter flounder (P. americanus) smooth flounder (L. putnami), tomcod (Microgadus tomcod), and grubby (Myoxocephalus aenaeus), Silversides and killfishes have varying periods of inshore abundance. Lowest numbers of silversides occurs during spring and early summer; peak abundance are during late summer and fall. Killfishes exhibit similar seasonal patterns in spring and summer. However, in the fall a general decline in abundance has been noted which is probably associated with movement to deeper estuarine water during cooler seasons.

4.28 Both adult and juvenile flounder inhabit the eelgrass beds from spring through midsummer. Grubby are generally found in the lower estuary, while tomcod and sticklebacks are more widely distributed.

4.29 Anadromous fishes such as smelt (Osmerus mordax), blueback herring (Alosa aestivalis), alewives (Alosa pseudoharengus) and coho salmon (Oncorhynchus kisutch) utilize the estuary and spawn in its tributaries. Smelt, followed by alewives and blueback herring, were the most common anadromous fishes captured during the Newington Generating Station Study. Smelt enter Great Bay estuary in late fall and winter and move up and down river channels with the tides. In spring, once ice-out conditions exist, spawning occurs in the tributaries. Adults then return to more saline waters and eventually leave the estuary. Schools of smelt, consisting primarily of young of the year, were abundant throughout the estuary in 1975. Highest numbers (appproximately 1500 per seine haul) were captured during summer. Alewives and blueback herring enter the estuary to spawn in spring. Alewives ascend tributaries to fresh water, whereas bluebacks may spawn at or just above tide water. Once spawning has been completed, adults of both species return to the estuary and move out to sea. Menhaden spawn in coastal waters and the young develop in adjacent estuaries. The Piscataqua River estuary once provided an important recreational and commercial fishery. There still are important sport fishery resources for striped bass, smelt and bait fish. Mackerel, cod and pollack are abundant in the open coastal areas. The shortnose sturgeon (Acipenser brevirostrum) is a rare and endangered species which has not been observed but may occur in the area.

4.30 Benthic Invertebrates. The occurrence of different populations of benthic organisms is generally related to bottom type. Populations can be defined in terms of the substrates they occupy. Mud-silt bottoms are predominantly inhabited by organisms that burrow or inhabitat various kinds of tubes (infauna). On hard bottom or rocky areas organisms generally live on the exposed substrate, attached or under rocks and shells (epifauna). Another way of describing the benthic fauna is in terms of the community. Certain groups of species occur together more or less consistently.

4.31. A long-term study for the Newington Generating Station has provided a great deal of information on the benthic invertebrate composition of the Piscataqua River. The organisms collected reflect a variety of substrate types, ranging from fine silt to sand and cobble. Dominant species found in the piscataqua River and Great Bay are listed in Table 4- . Overlapping of species does occur between bottom types. (13) Ampeliscan communities are common in sandy-silt bottoms. Nephtys-Nucula communities also occur on silty bottoms. The amphipods, Ampelisca abdita and A. vadorum and the cirripede Balamus crenatus have been found to be the most abundant benthic organisms in the Piscataqua sediments. They do, however, exhibit seasonal and annual fluctuations in relative abundance. Other abundant organisms are the amphipods, Phoxocephalu holbolli, Microdeutopus gryllotalpa, Unciola irrorata, Trichophoxus epistomus, and Corophium acherusicum-insidiosum; the polychaetes Nephtys caeca and Lumbrineris tenuis; the bivalves, Tellina agilis, Ensis directus, Mya arenaria, Cerastoderma pinnulatum, Lyonsia hyalina and Mytilus edulis, and the gastropods Nassarius trivittatus and Lunatia triseriata.

4.32 Wildlife-Mammals, Reptiles, Amphibians, Birds. Portsmouth Harbor is surrounded by a combination of industrial, commercial, and recreational land uses. Some wetlands do exist and provide habitats for reptiles, amphibians and mammals. Harbor seals (Phoca vitulina) are found in the Harbor and at the Isles of Shoals in early spring. Whales have been observed at the Isles of Shoals during migration.

The islands serve as stopovers for the fall and spring coastal migrations of many species of birds. The checklist for Appledore Island now includes over 125 species of birds. According to a survey of the State of Maine which has named at a protected natural area. The island contains the second most important heron rockery in the State. Here in season are found the Black Crowned Night Heron, Glossy Ibis, Snowy Egret, and pairs of Black Backed and Herring Gulls nests on the Islands each summer.

4.33 Shellfish. The shellfish inhabiting Portsmouth Harbor, Great Bay and the associated salt marshes include coastal and salt marsh species. The distribution of shellfish in the Piscataqua is shown in Figure 4- .

4.34 Bivalves, especially clams, compose an important shellfishery in the Piscataqua estuary. The tidal flats in the Great Bay yield the soft-shell clam (*Mya arenaria*), quahog clam (*Mercenaria mercenaria*). In addition to the clams, extensive blue mussell (*Mytilus edulis*) populations occur but this resource is only considered a limited sport fishery. A joint New Hampshire-Maine study is underway to develop the mussel resource, (14) while the American oyster (*Crassostrea virginica*) was once plentiful in the Great Bay, a small sport fishery currently exists. There has been limited commercial dragging for the deep sea scallop (Placopecten magellanicus) in the mouth of Portsmouth Harbor and around the Isles of Shoals. (40) The areas of Portsmouth Harbor and the Piscataqua River that will be dredged do not contain shellfish beds. (16)

4.35 The most important crustacean resources of the Portsmouth Harbor/Piscataqua River system are the lobster (*Homarus americanus*) and the rock crab (*Cancer irroratus*). Studies for the Newington Generating Station have found that both species are abundant in the Piscataqua. (37) Lobster distributions are shown in Figure 2-2. (38)

4.36 Historical and Archeological Features. The proposed improvement dredging of Portsmouth Harbor will not affect any historic or archeological sites. The Portsmouth area has numerous historic sites including Fort Constitution, William & Mary Raids, Fort McLary, John Paul Jones Park, and Fort Washington. The Sagamore Creek-Little Harbor area has recently been delineated as an area of major historic significance. (1) An historic district is officially proposed for the area between Portsmouth Bridge and Fort Constitution. As stated earlier, these sites will not be affected by the dredging project.

4.37 There appear not to be any archeological sites in the project area. However, coastal areas were inhabited by Indians for many centuries, and sites may remain undiscovered in the Portsmouth area.

4.38 Rare and Endangered Species. Several bird species which are in danger of extinction on a national level utilized the New Hampshire coastal area as a part of their habitat. These include the Hudsonian Godwit (*Limosa haemastical*, the peregrine falcon (*Falco peregrinus*), the bald eagle (*Haliacetus leucocephalus*), the clapper rail (*rallus longirostris*) and the brown pelican (*Pelecanus occidentalis*). The shortnose sturgeon (*Acipenser breuirastirum*) is a rare and endangered species which has not been observed, but may occur in the area. The proposed project will not adversely affect these species or their critical habitat. The Fish and Wildlife Service have indicated that there is a possibility that the endangered shortnose sturgeon inhabits the Piscataqua River. A request for a determination has been made by the Corps to the National Marine Fisheries Service, Gloucester.

V. COORDINATION

5.01 Coordination will be maintained through the Portsmouth Harbor-Piscataqua River Harbor Improvement Committee. Each stage of the study will also be presented for comment or concurrence by other Federal, State, regional, local, and civil agencies having an interest in the planning of navigation improvements to the Piscataqua River and related land and water resources. Interests will be kept informed of planning efforts and will be able to make comments and criticisms at informal workshop meetings which will be arranged when necessary. Two formal public meetings are scheduled; one during the formulation stage of the study, the other at the conclusion of the study to keep the public informed and to receive their views. Additional meetings can be arranged if the need arises.

5.02 A formulation stage public meeting will be held in the course of report preparation in order to present the advantages and disadvantages of all alternative solutions developed and to incorporate public views and desires in selection of alternatives and plan formulation. A late stage public meeting will be held before report completion to present the findings of detailed studies, including the rationale for any proposed solution, and the tentative recommendations.

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SEDIMENT ANALYSIS - PORTSMOUTH HARBOR, MAINE
OCTOBER 5, 1977 and AUGUST 1979

77-CHA02 PISCATAQUA RIVER YEAR 1977 STATE- NH TIDAL SYS- ME COM/REC- C+H

		01	02	03	04	05
LAB SERIAL NO.	(01)	100-252-1	100-252-2	100-252-3	100-252-4	100-252-5
EXPLORATION NO.	(02)	GE-1-77	GE-2-77	GE-3-77	GE-4-77	GE-5-77
SAMPLE NO.	(03)	B-1	B-1	B-1	B-1	B-1
SAMPLE DEPTH (FT)	(04)	SURFACE	SURFACE	SURFACE	SURFACE	SURFACE
LATITUDE	(05)					
LONGITUDE	(06)					
CO-ORD LOC-NORTH	(07)	104,500	102,050	92,890	90,060	100,160
CO-ORD LOC-EAST	(08)	327,740	330,480	340,970	344,900	332,600
SOUNDING	(11)	38.0	47.0	50.0	52.0	40.0
REDUCED SOUNDING-MLW	(12)	-28.0	-37.9	-38.0	-42.0	-32.9
DATE - HOUR	(13)	7207-0845	7207-0900	7207-0920	7207-0940	7207-1025
WEATHER	(14)	0.1	0.1	0.1	0.1	0.1
SEA STATE	(15)	0.1	0.1	0.1	0.1	0.1
SECCHI DISC-BLACK	(16)	4.0	4.2	4.0	4.3	4.0
SECCHI DISC-WHITE	(17)	5.0	5.2	5.1	5.2	5.0
	(20)	LIGHT	GRAVEL(GP)	GRAVEL(GP)	GRAVEL(GP)	LIGHT
	(21)	BROWN	W/ALGAE	W/ALGAE	W/ALGAE	BROWN
	(22)	MEDIUM	AND	SHELL	AND	MEDIUM
VISUAL	(23)	TO FINE	MARINE	FRAGMENTS	MARINE	TO FINE
CLASSIFICATION	(24)	SAND(SP)	ODOR	AND	ODOR	SAND(SP)
BY	(25)	W/NUMEROUS		MARINE		W/MARINE
LABORATORY	(26)	PERIWINKLES,		ODOR		ODOR
	(27)	SEAWEED				
	(28)	AND SHELL				
	(29)	FRAGMENTS				
SOIL CLASS/DOMIN	(32)	S	G	G	G	S
SOIL CLASS/SUB-DOMIN	(33)					
GRAIN SIZE CURVE-MED	(34)					0.320
GRAIN SIZE CURVE-Q1	(35)					0.450
GRAIN SIZE CURVE-Q3	(36)					0.260
SRT COEF=(Q1/Q3)**.5						1.3155
GR SIZE CURVE-% FINE	(38)					0
NORMAL/BIMODAL	(39)					N
LIQUID LIMIT	(40)					
PLASTIC LIMIT	(41)					
PLASTIC INDEX	(42)					
SPEC GRAV SOLIDS	(47)	2.65				2.67
WET UNIT WGT (PCF)	(48)					
DRY UNIT WGT (PCF)	(49)					
PERCENT SOLIDS	(50)					
SEDIMENT PH	(51)	6.45				6.32
SED RDX POT (MV)	(52)	0.005				

BOTTOM SEDIMENT SAMPLE TEST RESULTS
STATUS AS OF 05 OCT 77

PROJECT SUMMARY		NUMBER OF OBSERVATIONS	RANGE OF VALUES LOWEST	HIGHEST	MEAN (AVG VALUE)	STANDARD DEVIATION
GRAIN SIZE CURVE-MED	(34)	1	0.320000	0.320000	0.320000	
GRAIN SIZE CURVE-Q1	(35)	1	0.450000	0.450000	0.450000	
GRAIN SIZE CURVE-Q3	(36)	1	0.260000	0.260000	0.260000	
SRT COEF=(Q1/Q3)**.5		1	1.315587	1.315587	1.315587	
GR SIZE CURVE-% FINE	(38)	1	0.000000	0.000000	0.000000	
LIQUID LIMIT	(40)					
PLASTIC LIMIT	(41)					
PLASTIC INDEX	(42)					
SPEC GRAV SOLIDS	(47)	2	2.650000	2.670000	2.660000	0.014142
WET UNIT WGT (PCF)	(48)					
DRY UNIT WGT (PCF)	(49)					
PERCENT SOLIDS	(50)					
SEDIMENT PH	(51)	2	6.320000	6.450000	6.385000	0.091923
SED RDX POT (MV)	(52)	1	0.005000	0.005000	0.005000	
% VOL SOLIDS- EPA	(57)					
% VOL SOLIDS- NED	(58)					
% TOT VOL SOL-EPA	(59)					
PPM CHEM OXYGEN DMND	(60)					
PPM TOT KJDL NIT	(61)					
PPM OIL + GREASE	(62)					
PPM MERCURY	(63)					
PPM LEAD	(64)					
PPM ZINC	(65)					
PPM ARSENIC	(70)					
PPM BISMUTH	(71)					
PPM CADMIUM	(72)					
PPM CHROMIUM	(73)					
PPM COPPER	(74)					
PPM IODINE	(75)					
PPM NICKEL	(76)					
PPM PHOSPHORUS	(77)					
PPM SILVER	(78)					
PPM TIN	(79)					
PPM VANADIUM	(80)					
% CARBON (ORGANIC)	(85)					
% CARBON (CARBONATE)	(86)					
% CARBON (TOTAL)	(87)					
% HYDROGEN	(88)					
% NITROGEN	(89)					
PPM BENZENE	(90)					
PPB DDT	(91)					
PPB PLYCHL BIPH	(92)					
CARBON 14 (YRS)	(93)					
RADIOACTIVITY(MR/HR)	(94)	2	0.000000	0.000000	0.000000	

PROG #: 401U3D0801 BOTTOM SEDIMENT SAMPLE TEST RESULTS RCS NEDED-6
PAGE: 79-AA104- 01 STATUS AS OF 27 AUG 79

79-AA104 PISCATAQUA RIVER YEAR- 1979 STATE- NH TIDAL SYS- ME COM/REC- C

		01	02	03	04	05
LAB SERIAL NO.	(01)	100-295-1	100-295-2	100-295-3		
EXPLORATION NO.	(02)	PE-1-79	PE-2-79	GE-4-79		
SAMPLE NO.	(03)	PE-1-79	PE-2-79	GE-4-79		
SAMPLE DEPTH (FT)	(04)	0.0-1.0	0.0-1.3'	SURFACE		
LATITUDE	(05)					
LONGITUDE	(06)					
CO-ORD LOC-NORTH	(07)	92,430	92,100	91,940		
CO-ORD LOC-EAST	(08)	341,940	342,300	341,975		
SOUNDING	(11)	9.0	8.0	9.0		
REDUCED SOUNDING-MLW	(12)	-2.0	-1.0	-2.0		
DATE - HOUR	(13)	790508	790509	790510		
WEATHER	(14)	03	03	03		
SEA STATE	(15)	1	1	1		
SECCHI DISC-BLACK	(16)	BOTTOM	BOTTOM	BOTTOM		
SECCHI DISC-WHITE	(17)	VISIBLE	VISIBLE	VISIBLE		
	(20)	GRAVELLY	GRAVELLY	GRAVELLY		
	(21)	CLAYEY	CLAYEY	SAND		
	(22)	SAND	SAND	(SP)		
VISUAL	(23)	(SC)	(SC)			
CLASSIFICATION	(24)	WITH	WITH			
BY	(25)	ORGANICS	ORGANICS			
LABORATORY	(26)					
	(27)					
	(28)					
	(29)					
SOIL CLASS/DOMIN	(32)					
SOIL CLASS/SUB-DOMIN	(33)					
GRAIN SIZE CURVE-MED	(34)	0.495	0.530	4.765		
GRAIN SIZE CURVE-Q1	(35)	2.000	1.650	15.000		
GRAIN SIZE CURVE-Q3	(36)	0.155	0.185	0.700		
SRT COEF-(Q1/Q3)**.5		3.5921	2.9864	4.6291		
GR SIZE CURVE-% FINE	(38)	16.50	14.00	2.50		
NORMAL/BIMODAL	(39)	N	N	B		
LIQUID LIMIT	(40)	70	50			
PLASTIC LIMIT	(41)	32	25			
PLASTIC INDEX	(42)	38	25			
SPEC GRAV SOLIDS	(47)	2.67	2.68			
WET UNIT WGT (PCF)	(48)					
DRY UNIT WGT (PCF)	(49)					
PERCENT SOLIDS	(50)	43.00	80.00	59.00		
SEDIMENT PH	(51)	6.70	7.10	7.10		
SED RDX POT (MV)	(52)					

PROG #: 401U3D0801 BOTTOM SEDIMENT SAMPLE TEST RESULTS RCS NEDED-6
PAGE: 79-AA104- 02 STATUS AS OF 27 AUG 79

79-AA104 PISCATAQUA RIVER YEAR= 1979 STATE= NH TIDAL SYS= ME COM/REC= C

		01	02	03	04	05
% VOL SOLIDS- EPA	(57)	8.2	2.3	2.7		
% VOL SOLIDS- NED	(58)	5.1	0.9	1.3		
% TOT VOL SOL-EPA	(59)					
PPM CHEM OXYGEN DMND	(60)	8900.0	1200.0	1900.0		
PPM TOT KJDL NIT	(61)	2900.0	370.0	500.0		
PPM OIL + GREASE	(62)	3960.0	40.0	290.0		
PPM MERCURY	(63)	.LT. 0.2	.LT. 0.2	.LT. 0.2		
PPM LEAD	(64)	20.0	10.0	60.0		
PPM ZINC	(65)	42.0	24.0	35.0		
PPM ARSENIC	(70)	.LT. 0.5	.LT. 0.3	.R2.		
PPM BISMUTH	(71)					
PPM CADMIUM	(72)	2.0	1.0	2.0		
PPM CHROMIUM	(73)	92.0	18.0	20.0		
PPM COPPER	(74)	34.0	8.0	8.0		
PPM IODINE	(75)					
[illegible]	(76)	[illegible]	[illegible]	[illegible]		
PPM PHOSPHORUS	(77)					
PPM SILVER	(78)					
PPM TIN	(79)					
PPM VANADIUM	(80)	81.0	16.0	53.0		
% CARBON (ORGANIC)	(85)					
% CARBON (CARBONATE)	(86)					
% CARBON (TOTAL)	(87)					
% HYDROGEN	(88)					
% NITROGEN	(89)					
PPM BENZENE	(90)					
PPB DDT	(91)					
PPB PLYCHL BIPH	(92)					
CARBON 14 (YRS)	(93)					
RADIOACTIVITY(MR/HR)	(94)	6.0	10.0	8.0		

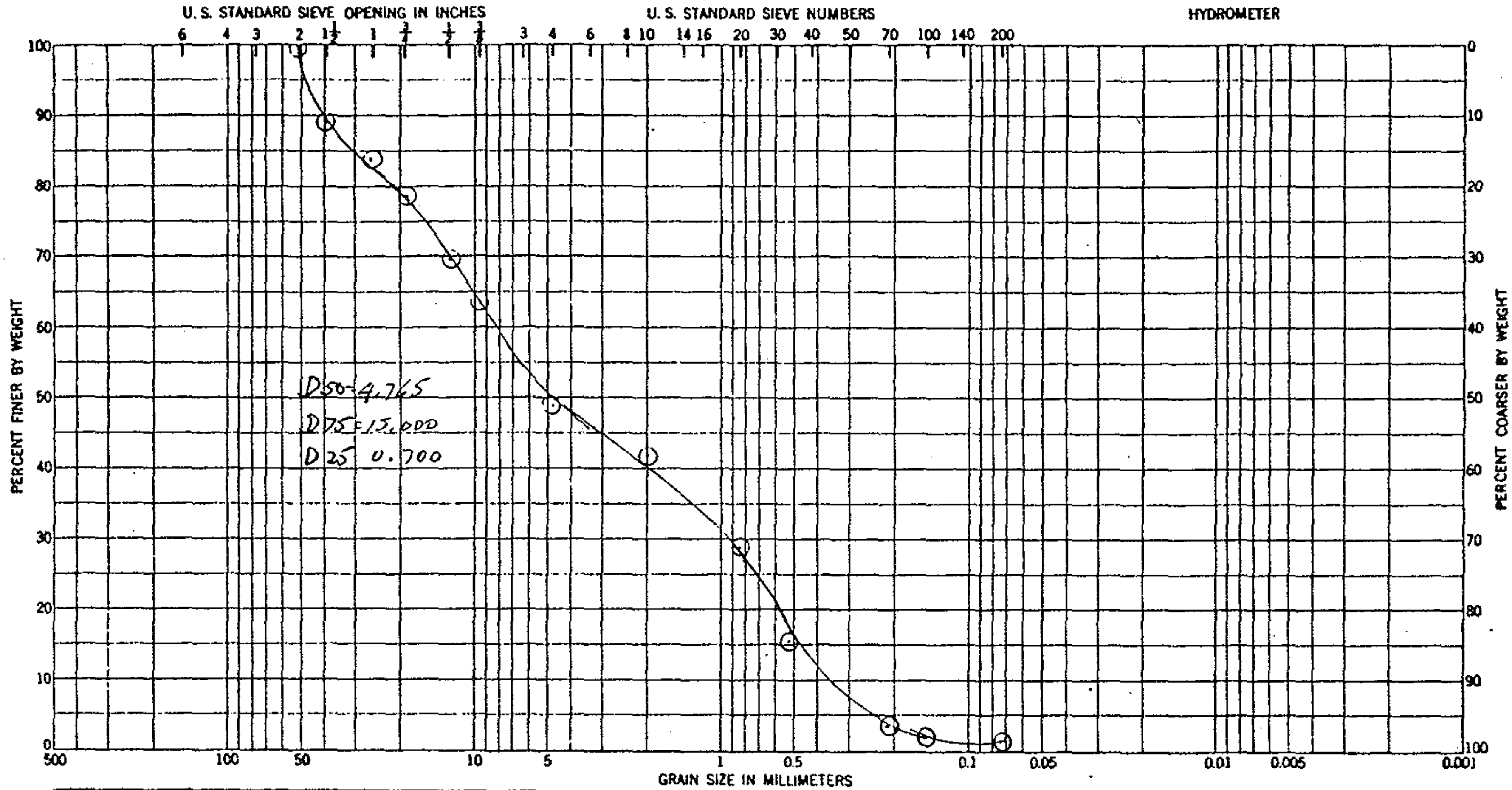
ALL TESTS, UNLESS OTHERWISE NOTED, WERE PERFORMED IN ACCORDANCE WITH THE EPA CHEMISTRY LABORATORY MANUAL.

REMARKS-
(R1)- RADIOACTIVITY BACKGROUND - 8 COUNTS/MINUTE (C/M)
(R2)- ANALYSIS NOT SUCCESSFUL - WILL REPEAT AT LATER DATE
(R3)-
(R4)-
(R5)-

LEGEND:
LI- LIMIT OF INSTRMT
NP- NON-PLASTIC
LT- LESS THAN
GT- GREATER THAN

PROG #: 401U300801 BOTTOM SEDIMENT SAMPLE TEST RESULTS RCS NEDED-6
PAGE: 79-AA104- 03 STATUS AS OF 27 AUG 79

PROJECT SUMMARY		NUMBER OF OBSERVATIONS	RANGE OF VALUES LOWEST	HIGHEST	MEAN (AVG VALUE)	STANDARD DEVIATION
GRAIN SIZE CURVE-MED	(34)	3	0.495000	4.765000	1.930000	2.455244
GRAIN SIZE CURVE-Q1	(35)	3	1.650000	15.000000	6.216667	7.608602
GRAIN SIZE CURVE-Q3	(36)	3	0.155000	0.700000	0.346667	0.306363
SRT COEF-(Q1/Q3)**.5		3	2.986456	4.629100	3.735887	0.830707
GR SIZE CURVE-% FINE	(38)	3	2.500000	16.500000	11.000000	7.466592
LIQUID LIMIT	(40)	2	50.000000	70.000000	60.000000	14.142135
PLASTIC LIMIT	(41)	2	25.000000	32.000000	28.500000	4.949747
PLASTIC INDEX	(42)	2	25.000000	38.000000	31.500000	9.192388
SPEC GRAV SOLIDS	(47)	2	2.670000	2.680000	2.675000	0.007071
WET UNIT WGT (PCF)	(48)					
DRY UNIT WGT (PCF)	(49)					
PERCENT SOLIDS	(50)	3	43.000000	80.000000	60.666667	18.556220
SEDIMENT PH	(51)	3	6.700000	7.100000	6.966667	0.230940
SED RDX POT (MV)	(52)					
% VOL SOLIDS- EPA	(57)	3	2.300000	8.200000	4.400000	3.296968
% VOL SOLIDS- NED	(58)	3	0.900000	5.100000	2.433333	2.318045
% TOT VOL SOL-EPA	(59)					
PPM CHEM OXYGEN DMND	(60)	3	1,200.000000	8,900.000000	4,000.000000	4,257.933771
PPM TOT KJDL NIT	(61)	3	370.000000	2,900.000000	1,256.666667	1,424.652004
PPM OIL + GREASE	(62)	3	40.000000	3,960.000000	1,430.000000	2,194.607026
PPM MERCURY	(63)	3	0.200000	0.200000	0.200000	
PPM LEAD	(64)	3	10.000000	60.000000	30.000000	26.457513
PPM ZINC	(65)	3	24.000000	42.000000	33.666667	9.073771
PPM ARSENIC	(70)	2	0.300000	0.500000	0.400000	0.141421
PPM BISMUTH	(71)					
PPM CADMIUM	(72)	3	1.000000	2.000000	1.666667	0.577350
PPM CHROMIUM	(73)	3	18.000000	92.000000	43.333333	42.158431
PPM COPPER	(74)	3	8.000000	34.000000	16.666667	15.011106
PPM IODINE	(75)					
PPM NICKEL	(76)	3	14.000000	84.000000	47.333333	35.118845
PPM PHOSPHORUS	(77)					
PPM SILVER	(78)					
PPM TIN	(79)					
PPM VANADIUM	(80)	3	16.000000	81.000000	50.000000	32.603680
% CARBON (ORGANIC)	(85)					
% CARBON (CARBONATE)	(86)					
% CARBON (TOTAL)	(87)					
% HYDROGEN	(88)					
% NITROGEN	(89)					
PPM BENZENE	(90)					
PPB DDT	(91)					
PPB PLYCHL BIPH	(92)					
CARBON 14 (YRS)	(93)					
RADIOACTIVITY(MR/HR)	(94)	3	6.000000	10.000000	8.000000	2.000000



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
B1	Surface	Gravelly SAND (SP)				

Project Portsmouth Harbor
Piscataqua River, N.H.

Area

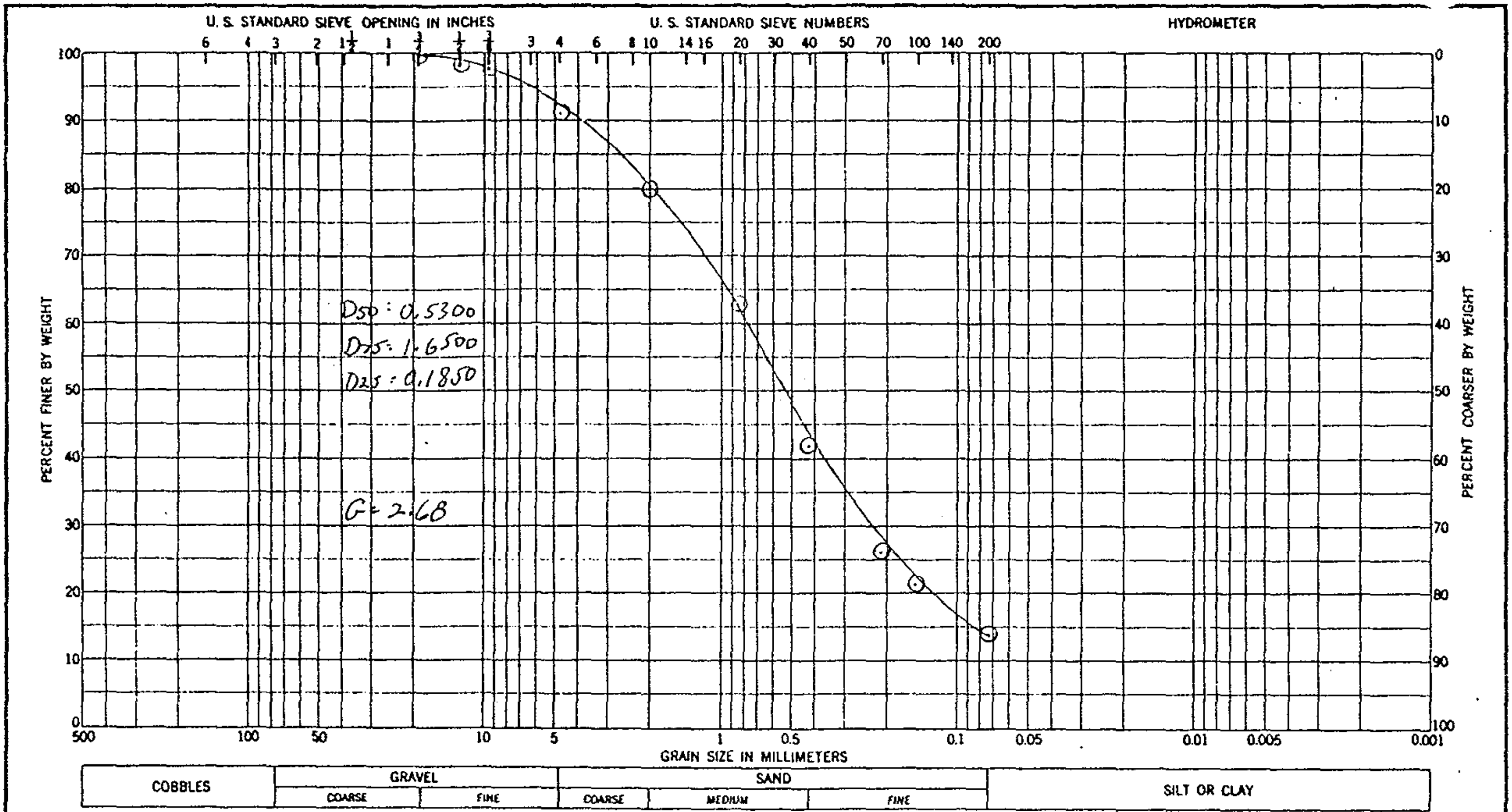
Boring No. GE 4-79 (Lab. Ser. No. 100-295-3)

Date June 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

GPO 926-260



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
T2	0.0'-1.3'	Gravelly Clayey SAND(SC)		50	25	25
		w/organics		*37	25	12
		*Overdried @ 140° F				

Project Portsmouth Harbor
Piscataque River, NH

Area

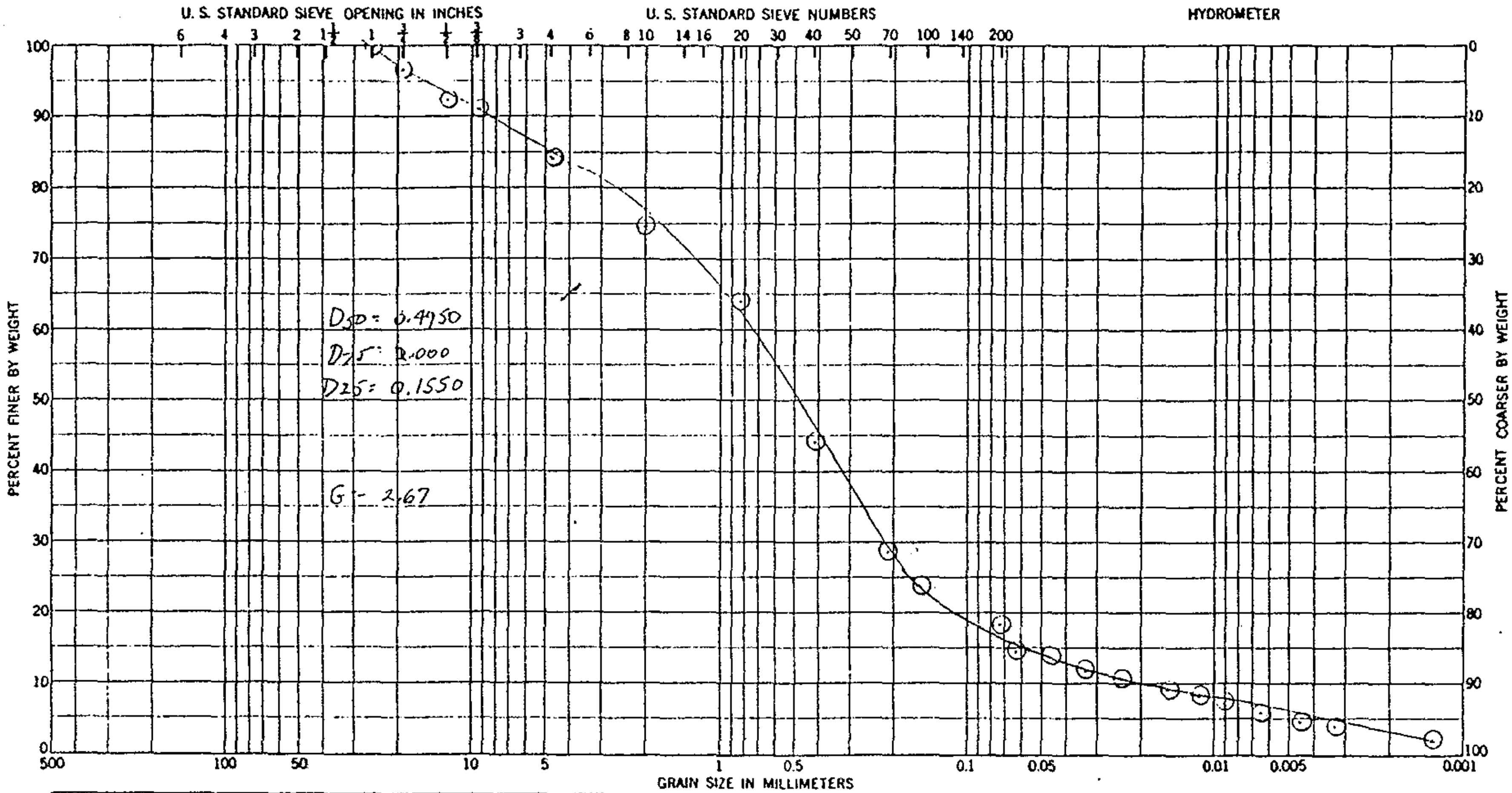
Boring No. PE2-79 (Lab. Ser. No 100-295-2)

Date June 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

GPO 926-280



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
T4	0.0 – 1.0'	Gravelly Clayey SAND (SC)		70	32	38
		w/ organics		*51	33	18
		*Tested of ovendried @ 140°F				

Project Portsmouth Harbor
Piscataque River, N.H.

Area

Boring No. PE 1-79 (Lab. Se. No. 100-295-1)

Date June 1979

GRADATION CURVES

ENG FORM 1 MAY 63 2087

GPO 926-250

PORTSMOUTH HARBOR - PISCATAQUA RIVER

Economics Appendix

Methodology

The economic justification of the proposed improvements was determined by comparing the equivalent average annual benefits accruing to the project over its economic lifespan to the equivalent average annual costs. In general, the benefits should equal or exceed the costs for the Federal Government to participate in the project. However, non-quantifiable environmental quality benefits may also lead to the recommendation of a plan.

Benefits and costs are compared by putting them on an average annual basis using an interest and amortization rate of 7 3/8% currently applicable to Federal projects. The economic life of the project is considered to be 50 years.

First Cost

Area 1

		($1,000's)
Dredging Overburden 194,000 cy @ $8.35/cy		$ 1,620.0
Remove Ledge Rock 278,000 cy @ $35/cy		9,730.0
	Subtotal	$11,353.0
Contingencies (15%)		1,703.0
	Subtotal	$13,053.0
E & D (4%)		522.0
S & A (6%)		784.0
	TOTAL FIRST COST	$14,360.0

Area 2

		($1,000's)
Dredging Overburden 117,000 cy @ $8.35/cy		$ 977.0
Remove Ledge Rock 176,000 cy @ $35/cy		6,160.0
	Subtotal	$ 7,137.0
Contingencies (15%)		1,070.6
	Subtotal	$8,207.6
E & D (4%)		328.3
S & A (6%)		492.5
	TOTAL FIRST COST	$9,028.4

Area 3

		($1,000's)
Dredging Overburden 34,000 cy @ $8.35/cy		$ 284.0
Remove Ledge Rock 27,000 cy @ $35/cy		945.0
	Subtotal	$ 1,229.0
Contingencies (15%)		184.4
	Subtotal	$ 1,413.4
E & D (4%)		56.5
S & A (6%)		84.8
	TOTAL FIRST COST	$ 1,554.7

Annual Charges

Interest and Amortization - 7 3/8%, 50-year project life
Capital Recovery Factor - .075913, January 1980 price level

Area 1

(14,360,000) (0.075913) = $1,090,111

Area 2

(9,028,400) (0.075913) = $685,000

Area 3

(1,554,700) (0.075913) = $118,000

Benefits

Project improvements would result in navigation benefits derived from: (1) the projected savings in the cost of transporting commodities on the improved waterway, (2) the removal of hazards to shipping and (3) the intangible value provided for national defense and emergencies. A monetary value is assigned to the transportation cost savings resulting from the channel modification.

Assigning a dollar value to the benefit resulting from the removal of hazards to shipping would require the development of a probability schedule of potential damages. Since few navigation-related accidents and damages have actually occurred in the past, it is not possible to determine future damages based on Portsmouth data alone. The unique features of Portsmouth Harbor, including the strong currents and channel configuration also make comparison with other ports difficult. The removal of shipping hazards is, therefore, not assigned a monetary value.

The value provided to national defense and emergencies is related to the fact that the daily movement of commodities on U.S. waterways is vital for security. Since this benefit is considered intangible, it is not quantifiable but becomes especially significant when one consideres that Pease Air Force Base and the Portsmouth U.S. Naval Shipyard are located in the vicinity of the project area.

In determining project benefits discussions were held with representatives of the Piscataqua River Safety and Water Improvement Committee, the Portsmouth Pilot, and various terminal operators and shipping interests.* These discussions led to the following findings:

1. All harbor users would benefit from improved safety.

2. Some users indicated the project would allow the use of larger ships and that they would definitely use the larger vessels to obtain efficiencies of scale and reduced transportation costs. These users are:

* For a list of the companies and organizations contacted see page

a. ATC, Newington
b. Belcher New England
c. Dorchester Sea - 3
d. Granite State Minerals
e. Northeast Petroleum
f. Sprague (includes ATC Portsmouth, Public Service)

3. Petroleum products would comprise the largest group of commodities that could be transported at a reduced cost if the project is implemented.

4. There would be a reduction in the transportation costs of salt shipments if the project is completed.

5. Gypsum, lumber, metals, machinery, and small quantities of other commodities are shipped through Portsmouth. It was determined that these shipping interests would maintain use of their present vessels or vessels of the same dimensions and would, therefore, not obtain transportation savings. Among the firms that failed to show a firm commitment toward use of larger vessels should the project be completed, were some companies dealing with petroleum products.

6. All dollar benefits must be attributed to the improvements to Area 1 alone. Representatives of the pilots at Portsmouth indicate that even if just Area 1 is improved, larger vessels would be able to navigate the channel. Improvements to Areas 2 and 3 would reduce the safety hazard but would not reduce transportation costs directly.

Petroleum Products

Petroleum products comprise the majority of waterborne commerce at Portsmouth. The following table shows that shipping traffic of petroleum products at Portsmouth has grown fairly steadily in recent years.

TABLE 1

Portsmouth: Trends in Petroleum Products
Sector of Waterbourne Commerce

Year	Short Tons Shipped
1968	1,592,648
1969	1,473,478
1970	1,868,497
1971	1,905,673
1972	1,861,787
1973	2,094,119
1974	2,121,648
1975	2,741,460
1976	2,860,937
1977	3,268,518

SOURCE: Waterborne Commerce of the United States

According to petroleum products distributors, the trend has been to increase the size of tankers to minimize transportation costs. A check of trips and drafts of inbound self-propelled tankers at Portsmouth for the years 1968-1977 shows that in 1968 just 6 trips had been made by tankers with drafts of 35 feet or more. By 1977, approximately 47 trips were made by the same size vessels.

Discussion with representatives of firms dealing with petroleum products reveals that at present the average oil tanker~~s~~ in use at Portsmouth is approximately 35,000 dead weight tons (DWT). Indications are that the average tanker size will increase if improvements are made to the channel. It is likely that the new average vessel size will be 40,000 DWT if the project is implemented.

Input from oil companies and area pilots suggests that vessels measuring 45,000 DWT could be used if channel modifications are made but in most cases the drafts of these vessels would be too great to allow them to come into the port fully-loaded. A 45,000 DWT vessel would draw 38 to 40 feet fully loaded. The channel depth will remain at the 35 feet mean low water level even with improvements. This means that if 45,000 DWT ships were to be consistently used, they would in most cases have to be light-loaded on minimum an average of two feet. In most instances this would prove more costly than bringing in a fully-loaded vessel of 40,000 DWT. (This is illustrated in Table 4.)

In addition to the fact that the use of light-loaded 45,000 DWT vessels is sometimes economically unsound, 45,000 DWT ships are somewhat unusual in size, at least domestically, and, therefore, may be difficult to obtain. Also, even if the channel depth were sufficient to allow for fully-loaded 45,000 tankers, the ability of the tugs currently in operation at Portsmouth to handle fully-loaded 45,000 DWT vessels is questionable.

Among the petroleum-based products which are imported at Portsmouth are liquid propane gas (LPG) and butane. Much of the LPG and butane cargo is received on 40,000 cubic meter ships. Most LPG carriers being built today, however, are of the 50-59,000 cubic meter capacity. If the project is implemented, there would be more opportunity for safe delivery using the 50-59,00 cubic meter ships. Also a cost savings would result from the volume buying which would be facilitated by the use of larger vessels. (These savings are not quantified.)

Salt

Salt is imported to Portsmouth with dry bulk vessels of the 45-50,000 DWT range. These ships must first discharge part of their cargo at another port before entering Portsmouth. The harbor improvements would allow fully-loaded 45-50,000 DWT ships to be utilized, resulting in a transportation cost savings.

Benfit Methodology

To determine benefits it was necessary to find the cost of shipping products for conditions both with and without the project. The following general shipping costs were used in the computation of benefits:

TABLE 2
ESTIMATED AVERAGE COSTS OF OCEAN-GOING VESSELS

Tankers (Foreign Flag)

Vessel Capacity	Cost at Sea (per hour)	Cost in Port (per hour)	Average Speed (knots)	Hours to Load or Unload	Immersion Factor
20,000 DWT	$ 539	$ 438	15.5	24	80.4
25,000 DWT	600	438	15.6	24	92.4
37,000 DWT	599	470	15.5	24	109
50,000 DWT	711	542	16.0	30	147

Tankers (U.S. Flag)

Vessel Capacity	Cost at Sea (per hour)	Cost in Port (per hour)	Average Speed (knots)	Hours to Load or Unload	Immersion Factor
20,000 DWT	$1027	928	15.5	24	80.4
25,000 DWT	1114	956	16.0	24	92.4
37,000 DWT	1145	987	16.0	24	118
50,000 DWT	1246	1074	16.0	30	130

Dry Bulk Vessels (Foreign Flag)

Vessel Capacity	Cost at Sea (per hour)	Cost in Port (per hour)	Average Speed (knots)	Hours to Load or Unload	Immersion Factor
15,000 DWT	$ 532	$ 446	14.5	-	62.2
25,000 DWT	577	465	15	-	87.0
35,000 DWT	620	499	15	250 Tons/Hr	105.0
50,000 DWT	693	557	15	-	130.5

LPG Vessels

Vessel Capacity	Cost at Sea (per hour)	Cost in Port (per hour)	Average Speed (knots)	Hours to Load or Unload
10-29,000 cubic meters	$13,000	$11,000	15	1
30-39,000 cubic meters	16,000	13,000	16	1
40-49,000 cubic meters	20,000	15,000	17	1
50-59,000 cubic meters	24,000	16,000	17	1

SOURCE: U.S. Dept. Commerce, Maritime Administration, industry sources (Jan. 1979 Price Level)

The preceding table was used along with information provided by individual companies to determine unit transportation costs for petroleum products and salt. Where necessary, interpolations were made from Table 2. A typical derivation of unit delivery costs is shown in Table 3. This is followed by Table 4 which shows all unit delivery costs that were derived.

TABLE 3

TYPICAL DERIVATION OF UNIT DELIVERY COSTS

Vessel Capacity (DWT)	35,000	40,000	45,000
Travel Distance (two way, mi)	4,000	4,000	4,000
Average Speed (knots)	15.5	15.6	15.8
Time at Sea (hrs) (Travel Distance/Average Speed)	258	256	253
Cost/Hr at Sea	$600	$625	$668
Total Cost at Sea (Time at Sea X Cost at Sea)	$154,800	$160,000	$169,004
Time in Port (hrs)	48	50	56
Cost/Hr in Port	$468	$487	$514
Total Cost in Port (Time in Port X Cost in Port)	$22,464	$24,350	$28,784
Average Delay Cost	$ 2,902	$ 3,019	$ 3,187
Total Cost Per Trip (Total Cost at Sea + Total Cost in Port + Average Delay Cost)	$180,166	$187,369	$200,975
Load Per Trip (ST)	37,632	43,008	48,384
Unit Cost (Total Cost Per Trip/Load Per Trip)	$4.79	$4.36	$4.15

All vessels in example are Foreign Flag vessels.
Average delay cost = [(Max. Delay)^2/(2 X Tidal Cycle)] (Cost/Hr in Port)
Max Delay = 12.4 hrs., Tidal Cycle = 12.4 hrs., Average Delay = 6.2 hrs.
Load Per Trip = DWT X 1.12 ST/LT x .96
Load Per Trip Light Loaded = Load Full - (Immersion Factor X 1.12 ST/LT X 12 X # feet light loaded)
feet light loaded = 2

TABLE 4

Foreign Flag Tankers, Port of Orign - Nigeria

Vessel Capacity (DWT)	35,000	40,000	45,000 (light-loaded)
Travel Distance (Two Way)	5,400	5,400	5,400
Average Speed (Knots)	15.5	15.6	15.8
Time At Sea (Hours)	348	346	342
Cost/Hours at Sea	600	625	668
Total Cost at Sea	208,800	216,250	228,456
Time in Port (Hours)	48	50	52
Cost/Hours in Port	468	487	514
Total Cost In Port	22,464	24,350	26,728
Average Delay Cost	2,902	3,019	3,187
Total Cost Per Trip	234,166	243,619	258,371
Load Per Trip (ST)	37,632	43,008	44,836
Unit Cost	$6.22	$5.66	$5.76

DWT - Dead Weight Ton
ST - Short Ton

TABLE 4 (Continued)
DERIVATIONS OF UNIT DELIVERY COSTS

Foreign Flag Tankers, Port of Orign - Venezuela

Vessel Capacity (DWT)	30,000	40,000	45,000 (light-loaded)
Travel Distance (Two Way)	4,000	4,000	4,000
Average Speed (Knots)	15.6	15.6	15.8
Time At Sea (Hours)	256	256	253
Cost/Hours at Sea	600	625	668
Total Cost at Sea	153,600	160,000	169,004
Time in Port (Hours)	43	50	52
Cost/Hours in Port	468	487	514
Total Cost In Port	22,224	24,350	26,728
Average Delay Cost	2,871	3,019	3,187
Total Cost Per Trip	178,695	187,369	198,919
Load Per Trip (ST)	32,256	43,008	44,836
Unit Cost	$5.54	$4.36	$4.43

Foreign Flag Tankers, Port of Orign - Venezuela

Vessel Capacity (DWT)	35,000	40,000	45,000 (light-loaded)
Travel Distance (Two Way)	4,000	4,000	4,000
Average Speed (Knots)	15.5	15.6	15.8
Time At Sea (Hours)	258	256	253
Cost/Hours at Sea	600	625	668
Total Cost at Sea	154,800	160,000	169,004
Time in Port (Hours)	48	50	52
Cost/Hours in Port	468	487	514
Total Cost In Port	22,464	24,350	26,728
Average Delay Cost	2,902	3,019	3,187
Total Cost Per Trip	180,166	187,369	198,919
Load Per Trip (ST)	37,632	43,008	44,836
Unit Cost	$4.78	$4.36	$4.44

LPG Vessels, Port of Orign - Algeria

Vessel Capacity (cm)	10-29,000	30-39,000	40-49,000	50-59,000
Travel Distance (Two Way)	6,000	6,000	6,000	6,000
Average Speed (Knots)	15	16	17	17
Time At Sea (Days)	14.5	13	12.7	12.7
Cost/Day at Sea	13,000	16,000	20,000	24,000
Total Cost at Sea	188,500	208,000	254,000	304,800
Time in Port (Days)	2	2	2	4
Cost/Days in Port	11,000	13,000	15,000	16,000
Total Cost In Port	22,000	26,000	30,000	64,000
Average Delay Cost	2,842	3,358	3,875	4,133
Total Cost Per Trip	231,342	237,358	287,875	372,933
Load Per Trip (CM)	24000	35,000	45,000	55,000
Unit Cost	$10.67	$6.78	$6.40	$6.78

CM - Cubic Meter

TABLE 4 (Continued)
DERIVATIONS OF UNIT DELIVERY COSTS

LPG Vessels, Port of Orign - Persian Gulf

Vessel Capacity (cm)	10-29,000	30-39,000	40-49,000	50-59,000
Travel Distance (Two Way)	18,000	18,000	18,000	18,000
Average Speed (Knots)	15	16	17	17
Time At Sea (Days)	43.4	40.6	38.2	38.2
Cost/Day at Sea	13,000	16,000	20,000	24,000
Total Cost at Sea	564,200	649,600	764,000	916,800
Time in Port (Days)	2	2	2	4
Cost/Days in Port	11,000	13,000	15,000	16,000
Total Cost In Port	22,000	26,000	30,000	64,000
Average Delay Cost	2,842	3,358	3,875	4,133
Total Cost Per Trip	589,042	678,958	797,875	984,933
Load Per Trip (CM)	20,000	35,000	45,000	55,000
Unit Cost	$29.45	$19.40	$17.73	$17.91

LPG Vessels, Port of Orign - North Sea

Vessel Capacity (cm)	10-29,000	30-39,000	40-49,000	50-59,000
Travel Distance (Two Way)	6,600	6,600	6,600	6,600
Average Speed (Knots)	15	16	17	17
Time At Sea (Days)	16	15	14	14
Cost/Day at Sea	13,000	16,000	20,000	24,000
Total Cost at Sea	208,000	240,000	280,000	336,000
Time in Port (Days)	2	2	2	4
Cost/Days in Port	11,000	13,000	15,000	16,000
Total Cost In Port	22,000	26,000	30,000	64,000
Average Delay Cost	2,842	3,358	3,875	4,133
Total Cost Per Trip	232,842	269,358	313,875	404,133
Load Per Trip (CM)	20,000	35,000	45,000	55,000
Unit Cost	$11.64	$7.70	$6.98	$7.35

LPG Vessels, Port of Orign - Venezuela

Vessel Capacity (cm)	10-29,000	30-39,000	40-49,000	50-59,000
Travel Distance (Two Way)	4,000	4,000	4,000	4,000
Average Speed (Knots)	15	16	17	17
Time At Sea (Days)	9.6	9	8.5	8.5
Cost/Day at Sea	13,000	16,000	20,000	24,000
Total Cost at Sea	124,800	144,000	170,000	204,000
Time in Port (Days)	2	2	2	4
Cost/Days in Port	11,000	13,000	15,000	16,000
Total Cost In Port	22,000	26,000	30,000	64,000
Average Delay Cost	2,842	3,358	3,875	4,133
Total Cost Per Trip	149,642	173,358	203,875	272,133
Load Per Trip (CM)	20,000	35,000	45,000	55,000
Unit Cost	$7.48	$4.95	$4.53	$4.95

TABLE 4 (Continued)
DERIVATIONS OF UNIT DELIVERY COSTS

Foreign Flag Bulk Carrier, Port of Origin - Mexico

Vessel Capacity (DWT)	17,500	25,000	47,500	47,500
Travel Distance (Two Way)	9,536	9,536	9,536	9,536
Average Speed (Knots)	14.6	15	15	15
Time At Sea (Hours)	653	636	636	636
Cost/Hr at Sea	543	577	632	632
Total Cost at Sea	354,579	366,972	401,952	401,952
Time in Port (Hours)	150	216	408	408
Cost/Hr in Port	451	465	509	509
Total Cost In Port	67,650	100,440	207,672	207,672
Average Delay Cost	2,796	2,883	3,156	23,156
Total Cost Per Trip	425,025	470,295	612,780	632,780
Load Per Trip (ST)	18,816	26,880	51,072	51,072
Unit Cost	$22.59	$17.50	$12.00	$12.39

U.S Flag Tankers, Port of Origin - U.S. Gulf

Vessel Capacity (DWT)	25,000	38,000	40,000	45,000
Travel Distance (Two Way)	4,216	4,216	4,216	4,216
Average Speed (Knots)	16	16	16	16
Time At Sea (Hours)	264	264	264	264
Cost/Hr at Sea	1,114	1,153	1,168	1,207
Total Cost at Sea	294,096	304,392	308,352	318,648
Time in Port (Hours)	48	48	50	52
Cost/Hr in Port	956	994	1,007	1,041
Total Cost In Port	45,888	47,712	50,350	54,132
Average Delay Cost	5,927	6,163	6,243	6,454
Total Cost Per Trip	345,911	358,267	364,945	379,234
Load Per Trip (ST)	26,880	40,858	43,008	45,024
Unit Cost	$12.87	$8.77	$8.49	$8.42

Foreign Flag Tankers, Port of Orign - Venezuela

Vessel Capacity (DWT)	35,000	40,000	45,000 (light-loaded)
Travel Distance (Two Way)	4,000	4,000	4,000
Average Speed (Knots)	15.3	15.6	15.8
Time At Sea (Hours)	261	256	253
Cost/Hours at Sea	600	625	668
Total Cost at Sea	156,600	160,000	169,004
Time in Port (Hours)	48	50	52
Cost/Hours in Port	468	487	514
Total Cost In Port	22,464	24,350	26,728
Average Delay Cost	2,902	3,019	3,019
Total Cost Per Trip	181,966	187,369	198,751
Load Per Trip (ST)	37,632	43,008	44,836
Unit Cost	$4.84	$4.36	$4.43

For purposes of this study, it was assumed that 50-59,000 cubic meter ships will discharge part of their cargo at another port at an additional cost approximated by the cost of two days in port. This was done because it is likely that fully-loaded 50-59,000 cubic meter ships will have drafts too large to navigate the channel. Based on information provided by users of the ships involved, the aforementioned cost factor was utilized.

Barge traffic, which will not be affected by the channel modifications, and which in most cases is an insignificant portion of companies' shipping taffic, was not included.

Based on information provided by the salt importer, the cost of using a light-loaded bulk carrier was estimated to be $20,000 greater per trip than a comparable fully-loaded ship.

Once unit transportation costs were determined, it was necessary to determine the total amount of commodities each beneficiary would ship through Portsmouth during the lifetime of the project. This was done by questioning the individual firms concerning historical and projected data on petroleum products and salt shipments. Also projections on petroleum products developed by Resource Planning Associates, Inc., (RPA), were used.

The RPA projections, (Shown in Table 5), were derived from recently published U.S. Department of Energy, Energy Information Administration (EIA) forecasts* of demand for petroleum products for the New England region as a whole. The EIA forecasts were used by RPA in estimating the amount of various petroleum products that will be shipped through each major port (including Portsmouth) in 1985, 1990, and 1995.

Growth rates for the various petroleum ~~products~~ shipments were derived from RPA data on Portsmouth. The growth rate that was determined for the port as a whole was then applied to historical data provided by potential project beneficiaries. The use of this method requires the assumption of constant market shares over the project lifetime, but it was felt that this simplification was necessary to obtain a maximum degree of accuracy.

The projected shipments of commodities through Portsmouth by potential project beneficiaries is shown in Table 6. For salt shipments, projections used were the best estimates that could be provided by the salt importer at Portsmouth. Is should be noted that crude projections were not included in RPA data, so projections were derived from information provided by the crude importer at Portsmouth.

* For assumptions underlying EIA forecasts see page 25

RPA developed projections only through 1995 and the project lifetime extends until the year 2035. It was, therefore, necessary to assume that shipments in 2035 will remain at their 1995 level. This was considered to be the most appropriate method because older studies show an increasing trend in petroleum product shipments, but RPA's new study shows an overall declining trend partially due to conservation and conversion. Since the'are practical limits to both conservation and conversion, it was felt that maintenance of the 1995 level of shipments was the best approach.

Information on the size of ships to be used both with and without the project was obtained from individual firms. For each company, relevant unit costs were multiplied by the amount of the commodity to be shipped, resulting in an average annual transportion cost figure. This computation was done for conditions both with and without harbor improvements for various years over the project lifetime (1985-2035). Costs with the project were subtracted from costs without the project to determine total transporation cost savings. The present worth of the aggregate savings constitutes the average annual project benefits. The results of the described procedures are shown in Table 7.

TABLE 5

Shipments of Petroleum Products Through Major New England Ports

	1977	1985	1990	1995	
Portsmouth	2,120.4	2,386.6	2,417.8	2,248.8	(Thousands of Short Tons)

	1977-1985	1985-1990	1990-1995
Growth Rate	+12.6%	+1.3%	-7.0%

Shipments of Residual Fuels Through Major New England Ports

	1977	1985	1990	1995	
Portsmouth	889	852	892	681	(Thousands of Short Tons)

	1977-1985	1985-1990	1990-1995
Growth Rate	-4.2%	+4.7%	-23.7%

Shipments of Distillate Fuels Through Major New England Ports

	1977	1985	1990	1995	
Portsmouth	803	1,048	1,043	1,069	(Thousands of Short Tons)

	1977-1985	1985-1990	1990-1995
Growth Rate	+30.5%	-0.5%	+2.5%

Shipments of Liquid Gas Through Major New England Ports

	1977	1985	1990	1995	
Portsmouth	157	202	196	193	(Thousands of Short Tons)

	1977-1985	1985-1990	1990-1995
Growth Rate	+28.7%	-3.0%	-1.5%

SOURCE: Resource Planning Associates

TABLE 6
PROJECTED SHIPMENTS OF COMMODITIES
THROUGH PORTSMOUTH BY POTENTIAL PROJECT BENEFICIARIES

Commodity	Thousands of Short Tons Shipped				
	1978	1985	1990	1995	2035
Crude	387.3	770	770	770	770
Distillate Kerosene	655.3	803.9	800.7	816.5	816.5
LPG, Butane (Thous. of cm)	204.4	263.1	255.2	251.3	251.3
Residual	807.	780.2	1~~07,680~~ 809	657.1	657.1
Salt	350	350	350	350	350

Table 7

Benefits: Transportation Cost Savings

Commodity: Crude

1985

Without Project				With Project			
Ship Size	St/Yr	$/St	Cost ($)	Ship Size	St/Yr	$/St	Cost ($)
35,000 DWT	770000	6.22	4789400	35,000 DWT	0	6.22	0
40,000 DWT	0	5.66	0	40,000 DWT	770,000	5.66	4358200

1990

Without Project				With Project			
Ship Size	St/Yr	$/St	Cost ($)	Ship Size	St/Yr	$/St	Cost ($)
35,000 DWT	770000	6.22	4789400	35,000 DWT	0	6.22	0
40,000 DWT	0	5.66	0	40,000 DWT	770000	5.66	4358200
	770000		4789400		770000		4358200

1995

Without Project				With Project			
Ship Size	St/Yr	$/St	Cost ($)	Ship Size	St/yr	$/St	Cost ($)
35,000 DWT	770000	6.22	4789400	35,000 DWT	0	6.22	0
40,000 DWT	0	5.66	0	40,000 DWT	770000	5.66	4358200
	770000		4789400		770000		4358200

2035

Without Project				With Project			
Ship Size	St/Yr	$/St	Cost ($)	Ship Size	St/Yr	$/St	Cost ($)
35,000 DWT	770000	6.22	4789400	35,000 DWT	0	6.22	0
40,000 DWT	0	5.66	0	40,000 DWT	770000	5.66	4358200
	770000		4789400		770000		4358200

Savings:

1985 4789400 - 4358200 = $431200
1990 4789400 - 4358200 = $431200
1995 4789400 - 4358200 = $431200
2035 4789400 - 4358200 = $431200

Table 7

Benefits: Transportation Cost Savings

Commodity: Distillate

1985

Without Project				With Project			
Ship Size	St/Yr	$/St	Cost ($)	Ship Size	St/Yr	$/St	Cost ($)
25,000 DWT	219250	12.87	2821748	25,000 DWT	0	12.87	0
38,000 DWT	219250	8.77	1922823	38,000 DWT	186363	8.77	1634404
45,000 DWT (Light Loaded)	0	8.42	0	45,000 DWT	252138	8.42	2123002
	438500		4744571		436301		3757406

1990

Without Project				With Project			
Ship Size	St/Yr	$/St	Cost($)	Ship Size	St/Yr	$/St	Cost ($)
25,000 DWT	218150	12.87	2807591	25,000 DWT	0	12.87	0
38,000 DWT	218150	8.77	1913176	38,000 DWT	185428	8.77	1626204
45,000 DWT (light loaded)	0	8.42	0	45,000 DWT light loaded)	250873	8.42	2112351
	436300		4720767		436301		3738555

1995

Without Project				With Project			
Ship Size	St/Yr	$/St	Cost ($)	Ship Size	St/Yr	$/St	cost ($)
25,000 DWT	223600	12.87	2877732	25,000 DWT	0	12.87	0
38,000 DWT	223600	8.77	1960972	38,000 DWT	78260	8.77	686340
45,000 DWT Light Loaded	0	8.42	0	45,000 DWT light loaded	368940	8.42	3106475
	447200		4838704		447200		3792815

2035

Without Project				With Project			
Ship Size	St/Yr	$/St	Cost ($)	Ship Size	St/Yr	$/St	Cost ($)
25,000 DWT	223600	12.87	2877732	25,000 DWT	0	12.87	0
38,000 DWT	223600	8.77	1960972	38,000 DWT	0	8.77	0
45,000 DWT light loaded	0	8.42	0	45,000 DWT light loaded	447200	8.42	3765424
	447200		4838704		447200		3765424

*Since both Port of origin and Port of destination are domestic, benefits are halved to conform to Corps Regulations.

<u>Savings</u>

1985 4744571 - 3757406 = $987165 x½ = $493,583
1990 4720767 - 3738555 = $982212 x ½ = $491,106
1995 4838704 - 3792815 = $1045889 x ½ = $522,945
2035 4838704 - 3765424 = $1073280 x ½ = $536,640

Table 7

Benefits: Transportation Cost Savings

Commodity: Distillate, Kerosone 1985

Without Project				With Project			
Ship Size	St/Yr	$/St	Cost ($)	Ship Size	St/Yr	$/St	Cost ($)
30,000 DWT	197400	5.54	1093596	30,000 DWT	0	5.54	0
40,000 DWT	0	4.36	0	40,000 DWT	197400	4.36	860664
	197400		1093596		197400		860664

1990

Without Project				With Project			
Ship Size	St/Yr	$/St	Cost ($)	Ship Size	St/Yr	$/St	Cost ($)
30,000 DWT	196400	5.54	1088056	30,000 DWT	0	5.54	0
40,000 DWT	0	4.36	0	40,000 DWT	196400	4.36	856304
	196400		1088056		196400		856304

1995

Without Project				With Project			
Ship Size	St/Yr	$/St	Cost ($)	Ship Size	St/Yr	$/St	Cost ($)
30,000 DWT	201300	5.54	1115202	30,000 DWT	0	5.54	0
40,000 DWT	0	4.36	0	40,000 DWT	201300	4.36	877668
	201300		1115202		201300		877668

2035

Without Project				With Project			
Ship Size	St/Yr	$/St	Cost ($)	Ship Size	St/Yr	$/St	Cost ($)
30,000 DWT	201300	5.54	115202	30,000 DWT	0	5.54	0
40,000 DWT	0	4.36	0	40,000 DWT	201300	4.36	877668
	201300		1115202		201300		877668

Kerosene Shipments are included in the distillate Category.

Savings

1985 1093596 - 860664 = $232932
1990 1088056 - 856304 = $2311752
1995 1115202 - 877668 = $237534
2035 1115202 - 877668 = $237534

Table 7

Benefits: Transportation Cost Savings

Commodity: Distillate, Residual 1985

Without Project					With Project			
Ship size	St/yr	$/St	Cost ($)		Ship Size	St/Yr	$/St	Cost ($)
35,000 DWT	336000	4.78	1606080		35,000 DWT	33600	4.78	160608
40,000 DWT	0	4.36	0		40,000 DWT	302400	4.36	1318464
	336000		1606080			336000		1479072

1990

Without Project					With Project			
Ship Size	St/Yr	$/St	Cost ($)		Ship size	St/Yr	$/St	Cost ($)
35,000 DWT	336000	4.78	1606080		35,000 DWT	33600	4.78	160608
40,000 DWT	0	4.36	0		40,000 DWT	302400	4.36	1318464
	336000		1606080					1479072

1995

Without Project					With Project			
Ship Size	St/Yr	$/St	Cost ($)		Ship Size	St/Yr	$/St	Cost ($)
35,000 DWT	336000	4.78	1606080		35,000 DWT	33600	4.78	160608
40,000 DWT	0	4.36	0		40,000 DWT	302400	4.36	1318464
	336000		1606080					1479072

2035

Without Project					With Project			
Ship Size	St/Yr	$/St	Cost ($)		Ship Size	St/Yr	$/St	Costs ($)
35,000 DWT	336000	4.78	1606080		35,000 DWT	336000	4.78	160608
40,000 DWT	0	4.36	0		40,000 DWT	302400	4.36	1318464
	336000		1606080					1479072

Savings

1985 1606080 - 1479072 = $127008
1990 1606080 - 1479072 = $127008
1995 1606080 - 1479072 = $127008
2035 1606080 - 1479072 = $127008

Table 7

Benefits: Transportation Cost Savings

Commodity: Lpg, Butane 1985

Without Project				With Project			
Ship Size	Cm/Yr	$/Cm	Cost ($)	Ship Size	Cm/Yr	$/CM	Cost ($)
10-29,000 cm	17102	11.64	199067	10-29,000 cm	0	11.64	0
10-29,000 cm	5265	7.48	39382	10-29,000 cm	0	7.48	0
10-29,000 cm	3947	10.67	42114	10-29,000 cm	0	10.67	0
30-39,000 cm	26310	7.70	202587	30-39,000 cm	19733	7.70	151944
30-39,000 cm	10524	4.95	52094	30-39,000 cm	7893	4.95	39070
30-39,000 cm	7893	6.78	53515	30-39,000 cm	5920	6.78	40138
30-39,000 cm	7893	19.40	153124	30-39,000 cm	5920	19.40	114848
40-49,000 cm	26310	6.98	183644	40-49,000 cm	19733	6.98	137736
40-49,000 cm	10524	4.53	47674	40-49,000 cm	7893	4.53	35755
40-49,000 cm	7893	6.40	50515	40-49,000 cm	5920	6.40	37888
40-49,000 cm	7893	17.73	139943	40-49,000 cm	5920	17.73	104962
50-59,000 cm	65775	7.35	483446	50-59,000 cm	92085	7.35	676825
50-59,000 cm	26313	4.95	130429	50-59,000 cm	36834	4.95	182328
50-59,000 cm	19733	6.78	133790	50-59,000 cm	27626	6.78	187304
50-59,000 cm	19733	17.91	353418	50-59,000 cm	27626	17.91	494782
			2264562				2203580

LPG, Butane Shipments, Based on Information Supplied by the importer, Represent an Average based on Several Ports of origin.

Table 7

Benefits: Transportation Cost Savings

Commodity: LPG, Butane 1990

Without Project				With Project			
Ship Size	Cm/Yr	$/Cm	Cost ($)	Ship Size	Cm/Yr	$/CM	Cost ($)
10-29,000 cm	16588	11.64	193084	10-29,000 cm	0	11.64	0
10-29,000 cm	5104	7.48	38178	10-29,000 cm	0	7.48	0
10-29,000 cm	3828	10.67	40845	10-29,000 cm	0	10.67	0
30-39,000 cm	25520	7.70	196504	30-39,000 cm	19140	7.70	147378
30-39,000 cm	10208	4.95	50530	30-39,000 cm	7656	4.95	37897
30-39,000 cm	7656	6.78	51908	30-39,000 cm	5742	6.78	38931
30-39,000 cm	7656	19.40	148526	30-39,000 cm	5742	19.40	111395
40-49,000 cm	25520	6.98	178130	40-49,000 cm	19140	6.98	133597
40-49,000 cm	10208	4.53	46242	40-49,000 cm	7656	4.53	34682
40-49,000 cm	7656	6.40	48998	40-49,000 cm	5742	6.40	36749
40-49,000 cm	7656	17.73	135741	40-49,000 cm	5742	17.73	101806
50-59,000 cm	63800	7.35	468930	50-59,000 cm	89320	7.35	656502
50-59,000 cm	25520	4.95	126324	50-59,000 cm	35728	4.95	176854
50-59,000 cm	19140	6.78	129769	50-59,000 cm	26796	6.78	181677
50-59,000 cm	19140	17.91	342797	50-59,000 cm	26796	17.91	479916
			2196506				2137384

Table 7

Benefits: Transportation Cost Savings

Commodity: LPG, Butane 1995

Without Project					With Project			
Ship Size	Cm/Yr	$/CM	Cost ($)		Ship Size	Cm/Yr	$/Cm	Cost ($)
10-29,000 cm	15078	11.64	175508		10-29,000 cm	0	11.64	0
10-29,000 cm	6283	7.48	46997		10-29,000 cm	0	7.48	0
10-29,000 cm	3770	10.67	40226		10-29,000 cm	0	10.67	0
30-39,000 cm	12565	7.70	96751		30-39,000 cm	18848	7.70	145130
30-39,000 cm	6283	4.95	31101		30-39,000 cm	9424	4.95	46649
30-39,000 cm	3770	6.78	25561		30-39,000 cm	5654	6.78	38334
30-39,000 cm	2513	19.40	48752		30-39,000 cm	3770	19.40	73138
40-49,000 cm	25130	6.98	175407		40-49,000 cm	18848	6.98	131559
40-49,000 cm	12566	4.53	56924		40-49,000 cm	9424	4.53	42691
40-49,000 cm	7540	6.40	48256		40-49,000 cm	5654	6.40	36186
40-49,000 cm	5016	17.73	88934		40-49,000 cm	3770	17.73	66842
50-59,000 cm	75390	7.35	554116		50-59,000 cm	87955	7.35	646469
50-59,000 cm	37698	4.95	186605		50-59,000 cm	43978	4.95	217691
50-59,000 cm	22620	6.78	153364		50-59,000 cm	26387	6.78	178904
50-59,000 cm	15078	17.91	270047		50-59,000 cm	17591	17.91	315055
			1998549					1938648

Table 7

Benefits: Transportation Cost Savings

Commodity: LPG, Butane 2035

Without Project				With Project			
Ship Size	Cm/Yr	$/Cm	Cost ($)	Ship Size	Cm/Yr	$/CM	Costs($)
10-29,000 cm	7540	11.64	87766	10-29,000 cm	0	11.64	0
10-29,000 cm	3141	7.48	23495	10-29,000 cm	0	7.48	0
10-29,000 cm	1885	10.67	20113	10-29,000 cm	0	10.67	0
30-39,000 cm	12566	7.70	96758	30-39,000 cm	18848	7.70	145130
30-39,000 cm	6282	4.95	31096	30-39,000 cm	9424	4.95	46649
30-39,000 cm	3770	6.78	25561	30-39,000 cm	5654	6.78	38334
30-39,000 cm	2513	19.40	48752	30-39,000 cm	3770	19.40	73138
40-49,000 cm	31415	6.98	219277	40-49,000 cm	18848	6.98	131559
40-49,000 cm	15705	4.53	71143	40-49,000 cm	9424	4.53	42691
40-49,000 cm	9425	6.40	60320	40-49,000 cm	5654	6.40	36186
40-49,000 cm	6285	17.73	111433	40-49,000 cm	3770	17.73	66842
50-59,000 cm	75396	7.35	554160	50-59,000 cm	87955	7.35	646469
50-59,000 cm	37692	4.95	186575	50-59,000 cm	43978	4.95	217691
50-59,000 cm	22620	6.78	153364	50-59,000 cm	26387	6.78	178904
50-59,000 cm	15084	17.91	270154	50-59,000 cm	17591	17.91	315055
			1959967				1938648

Savings

1985 2264562 - 2203580 = $60982
1990 2196506 - 2137384 = $59122
1995 1998549 - 1938648 = $59901
2035 1959967 - 1938648 = $21319

Table 7

Benefits: Transportation Cost Savings

Commodity: Residual

1985

Without Project				With Project			
Ship Size	St/Yr	$/St	Cost ($)	Ship Size	St/Yr	$/St	Cost ($)
35,000 DWT	612200	4.84	2963048	35,000 DWT	153050	4.84	740762
40,000 DWT	0	4.36	0	40,000 DWT	459150	4.36	2001894
	612200		2963048		612200		2742656

1990

Without Project				With Project			
Ship Size	St/Yr	$/St	cost ($)	Ship Size	St/Yr	$/St	Cost ($)
35,000 DWT	641000	4.84	3102440	35,000 DWT	160250	4.84	775610
40,000 DWT	0	4.36	0	40,000 DWT	480750	4.36	2096070
	641000		3102440		641000		2871680

1995

Without Project				With Project			
Ship Size	St/Yr	$/St	Cost ($)	Ship Size	St/Yr	$/St	Cost ($)
35,000 DWT	489100	4.84	2367244	35,000 DWT	122275	4.84	591811
40,000 DWT	0	4.36	0	40,000 DWT	366825	4.36	1599357
	489100		2367244		489100		2191168

2035

Without Project				With Project			
Ship Size	St/Yr	$/St	Cost ($)	Ship Size	St/Yr	$/St	Costs ($)
35,000 DWT	489100	4.84	2367244	35,000 DWT	122275	4.84	591811
40,000 DWT	0	4.36	0	40,000 DWT	366825	4.36	1599357
	489100		2367244		489100		2191168

Savings:

1985 2963048 - 2742656 = $220392
1990 3102440 - 2871680 = $230760
1995 2367244 - 2191168 = $176076
2035 2367244 - 2191168 = $176076

Table 7

Benefits: Transportation Cost Savings

Commodity: Salt

1985

Without Project				With Project			
Ship Size	St/Yr	$/St	Cost ($)	Ship Size	St/Yr	$/St	Cost ($)
17500 DWT	70000	22.59	1581300	17500 DWT	35000	22.59	790650
25000 DWT	0	17.50	0	25000 DWT	35000	17.50	612500
47500 DWT	0	12.00	0	47500 DWT	280000	12.00	3360000
47500 DWT	280000	12.39	3469200	47500 DWT	0	12.39	0
Light Loaded	350000		5050500	lightloaded	350000		4763150

1990

Without Project				With Project			
Ship Size	St/Yr	$/St	Cost ($)	Ship Size	St/Yr	$/St	cost ($)
17500 DWT	70000	22.59	1581300	17500 DWT	35000	22.59	790650
25000 DWT	0	17.50	0	25000 DWT	35000	17.50	612500
47500 DWT	0	12.00	0	47500 DWT	280000	12.00	3360000
47500 DWT	280000	12.39	3469200	47500 DWT	0	12.39	0
Light loaded							
	350000		5050500	light loaded	350000		4763150

1995

Without Project				With Project			
Ship Size	St/Yr	$/St	Cost ($)	Ship Size	St/Yr	$/St	Cost ($)
17500 DWT	70000	22.59	1581300	17500	35000	22.59	790650
25000 DWT	0	17.50	0	25000 DWT	35000	17.50	612500
47500 DWT	0	12.00	0	47500 DWT	280000	12.00	3360000
47500 DWT	280000	12.39	3469200	47500 DWT	0	12.39	0
lightloaded				lightloaded			
	350000		5050500		350000		4763150

2035

Without Project				With Project			
Ship Size	St/Yr	$/St	Cost ($)	Ship Size	St/Yr	$/St	Cost ($)
17500 DWT	70000	22.59	1581300	17500 DWT	35000	22.59	790650
25000 DWT	0	17.50	0	25000 DWT	35000	17.50	612500
47500 DWT	0	12.00	0	47500 DWT	280000	12.00	3360000
47500 DWT	280000	12.39	3469200	47500 DWT	0	12.39	0
lightloaded				lightloaded			
	350000		5050500		350000		4763150

Savings

1985 5050500 - 4763150 = $287,350
1990 5050500 - 4763150 = $287,350
1995 5050500 - 4763150 = $287,350
2035 5050500- 4763150 = $287,350

TRANSPORTATION COST SAVINGS

1985	1990	1995	2035
$ 431,200	$ 431,200	$ 431,200	$ 431,200
493,583	491,106	522,945	536,640
232,932	231,752	237,534	237,534
127,008	127,008	127,008	127,008
60,982	59,122	59,901	21,319
220,392	230,760	176,076	176,076
287,350	287,350	287,350	287,350
$1,853,447	$1,858,298	$1,842,014	$1,817,127

Interest Rate - 7 3/8%
Capital Recovery Factor - .07591

Average Annual Benefits - $1,845,306 = approx. $1,845,000

Equivalent average annual benefits are $1,845,000. It should be noted that benefits could become larger if RPA forecasts of increased coal consumption occur. Dollar benefits are not computed for waterborne coal traffic since at this time there are no firm commitments to transport coal. If coal shipments do replace declining shipments of petroleum products, benefits would expand.

As noted previously, all dollar benefits must be attributed to the improvements to AREA 1. Improvements to AREAS 2 and/or 3 would reduce the safety hazard but would not reduce transportation costs directly.

In general, a project is sized to obtain maximization of net benefits, i.e., the point where the greatest excess of benefits over costs occurs. However, as in this case, when it is not possible to assign a monetary value to the removal of hazards to shipping, a sound judgement is made to whether the project is worth the cost.

Benefit-Cost Ratios

Alternative 1: Improvement to AREA 1
Benefits - $1,845,000
Costs - $1,093,000
BCR - 1.69

Alternative 2: Improvement to AREAS 1 and 3
Benefits - $1,845,000
Costs - $1,208,000
BCR - 1.52

Alternative 3: Improvements to AREAS 1, 2, and 3
Benefits - $1,845,000
Costs - $1,893,000
BCR - 0.97

Alternative 1 and 2 are economically feasible since their benefit-cost ratios are one or greater. Alternative 1 maximizes net benefits. Alternative 3 maximizes safety.

COMPANIES AND ORGANIZATIONS CONTACTED

ATC Newington
Barton Machine
Belcher New England
Dorchester Sea - 3 Products
Gendron Corporation
Granite State Minerals
Gulf Oil
Kittery Port Authority
Mobil Oil
National Gypsum
New England Tank Industries
New Hampshire State Port Authority
Northeast Petroleum
Pease AFB
P.E. Avery Corporation
Portsmouth Chamber of Commerce
Portsmouth Harbor - Piscataqua River Safety and Improvement Committee
Portsmouth Navy Base
Portsmouth Pilots
Simplex Wire and Cable
Sprague Terminal (ATC Portsmouth, Conoco, Public Service, Schiller)

ASSUMPTIONS UNDERLYING EIA FORECASTS

Supply-Related Assumptions

• Crude oil prices will be decontrolled by 1981.

• Natural gas prices to producers will be limited by the terms of the Natural Gas Policy Act of 1978.

• Imports of Canadian and Mexican natural gas and liquefied natural gas will be limted.

• The price of natural gas imports under new contracts will be tied to the work market price of oil.

• The Alaskan Natural Pipeline will be expanded to a capacity of 1.6 million barrels of oil a day by 1985, and to 2.2 million barrels a day by 1990.

• The PACTEX oil pipeline will be the only oil pipeline link connecting the West Coast to the midwestern and southwestern pipeline networks.*

• Export of domestically produced crude oil will not be permitted.

• Imports of petroleum products will be limited in order to encourage domestic refining.

Demand-Related Assumptions

• Only the coal-fire electric power plants currently in planning stages will be operating in 1985.

• Diesel cars and light-duty trucks will achieve 9.4 and 7.8 percent shares of their respective markets by 1985; thereafter, these shares will remain constant.

* This project was recently canceled.

s.a. alsup

SEISMIC REFRACTION INVESTIGATIONS
PISCATAQUA RIVER SHIP CHANNEL
KITTERY, MAINE AND PORTSMOUTH, NEW HAMPSHIRE

Prepared For: Department of the Army
Corps of Engineers
New England Division
Waltham, Massachusetts

File 7760
January 17, 1978

SEISMIC REFRACTION INVESTIGATIONS
PISCATAQUA RIVER SHIP CHANNEL
KITTERY, MAINE AND PORTSMOUTH, NEW HAMPSHIRE

1.00 INTRODUCTION

This report presents the results of marine seismic refraction investigations in the Piscataqua River near Kittery, Maine and Portsmouth, New Hampshire. The purpose of the effort was to determine the character and depths of materials below the River bottom as an aid to classifying materials that will have to be excavated in a channel widening project. Two specific areas were investigated: One area on the northeasterly side of the ship channel between Memorial Bridge and the New Hampshire and Maine Bridge over the Piscataqua River and another area on the southerly side of the channel north of Goat Island.

The investigation was conducted by S.A. Alsup & Associates of Waban, Massachusetts for the New England Division of the Department of the Army Corps of Engineers. Field investigations were made on December 12, 13, and 14 of 1977 with subsequent data analysis and interpretations forming the basis of this report. Engineering location control was provided by Town Planning and Engineering Associates, Inc. of Portsmouth, New Hampshire, explosives and licensed blasting personnel were assigned by Explosives Engineering, Inc. of Shirley, Massachusetts, and the field effort was conducted from a vessel owned and operated by Mr. Elmer Richardson of Kittery Maine. Personnel, materials, and marine vessel were supplied as subcontracts to S.A. Alsup & Associates.

Some 13,615 linear feet of marine seismic refraction profiles are reported below as a result of the investigation. Areas investigated are shown in Figures 1 and 2, with shot points (small black dots) indicated along each of the continuous profile alignments. These alignments cover the areas indicated by the Corps of Engineers as being of interest: Some additional profile data were obtained during the field operations, but only the general conditions outside the areas of interest to the Corps of Engineers are displayed in the resulting profiles.

Unfavorable field conditions were commonplace during the field investigation phase of the effort, including strong winds, freezing rain and snow, extreme high tides, and low ambient air temperatures. Approximately 15% of the field data were unuseable because of low temperature effects on development of photographic data charts and vessel-hydrophone alignment problems. The remainder of data is of good quality, and the results are expected to be reliable within the usual limitations for marine refraction data.

2.00 METHOD OF INVESTIGATION

This investigation was performed using a 12-element hydrophone string suspended two feet below water surface with 20-foot spacing between hydrophones. Small dynamite charges initiated by electric caps (¼-lb 40% gel w/instant caps) were used as an energy source in the first part of the field survey. Pre-formed "boosters" were used instead of dynamite during the last two days of field investigation. Procedures in the field data collection include:

1) Align vessel with transit control from selected positions on the New Hampshire & Maine Bridge while proceeding up-current with the hydrophone string trailing over the alignment. Nine positions corresponding to the nine alignments shown on Figure 1 were established prior to profiling. Point "SHAW" and three positions on Pierce Island (west of survey area, not shown) were used for the investigation area shown in Figure 2.

2) Drop weighted explosive charge to bottom, note water depth from fathometer, signal second transit position for azimuthal location control, move boat forward to place charge 50-feet from boat, note time-of-day.

3) Detonate charge and record hydroacoustic response from all hydrophones simultaneously.

4) Repeat Steps 1 through 3 above to continue profiling.

These procedures permit collection of the data needed to correct position and elevation parameters during the data reduction effort. Shot points were located by knowing the lateral position of the boat at charge-drop time from the aligning transit position, and the position along the alignment is determined from the measured angle referenced to baseline between the two transit positions. Water depth is measured directly from the fathometer, with correction to Mean Low Water Datum ("mlw" on the profiles shown below) from time-of-day and tidal charts. Depths were also checked by comparison of fathometer-position readings with bottom depths shown in maps of the area provided by the Corps of Engineers. Additional location notes were taken with regard to shoreline and marine features during the field investigation.

All alignments shown were investigated with "reversed-profiling" to the extent possible under existing tidal conditions. Line 12 (Figure 2) was not reversed because of the heavy concentration of lobster pots and small boat moorings in the area east of the Line 12 locale. These features also prevented further profiling to the east of Line 12. Complex river flow and tidal currents also prevented profiling in the area westerly of Line 5 (Figure 1) because a linear hydrophone string could not be established in that area under existing conditions.

The profiling reported here includes individual refraction profiles from the 176 shot points indicated in Figures 1 and 2.

3.00 DATA ANALYSIS

All data for this report were analyzed according to standard "cross-over distance" refraction procedures where the pattern of first arriving acoustic waves is plotted on a time-distance graph and distance to changes in slope in the pattern are used to calculate depth to major changes in velocity beneath the refraction spread (hydrophone string). Refraction velocities in the different materials beneath the spread are measured directly from the plotted data: Depth calculations using the velocities and cross-over distance are standard formulations.

Several corrections are required to make the calculated depths accurate and referenced to Mean Low Water as a datum:

1) add to calculated depth from plotted data:

    charge depth
    hydrophone string depth

2) subtract from calculated depth:

    tidal elevation above mlw

3) correct for distance between first hydrophone and shot point according to water depth (a fixed boat to shot distance of 50-feet is used for this particular investigation, with first hydrophone 60-feet from the stern of the boat.

IT IS IMPORTANT TO NOTE IN THIS SURVEY THAT STRONG EASTERLY STORM WINDS WERE ACTIVE ON THE SEACOAST AND MAXIMUM HIGH TIDES WERE PRESENT AT TIME OF SURVEY IN THE FIELD INVESTIGATION. LOCAL SOURCES INDICATE THAT ACTUAL TIDES MAY BE SEVERAL FEET HIGHER THAN TIDAL CHARTS STATE UNDER SUCH CONDITIONS. CORRECTIONS WERE MADE ON THE BASIS OF MAXIMUM HIGH TIDE (11 to 12 feet) IN PRESENTING THE REFRACTION PROFILES, AND AN ERROR MAY BE PRESENT DUE TO THIS EFFECT. ELEVATIONS SHOWN WILL BE TOO SHALLOW (HIGHER) THAN ACTUAL IF THIS ERROR IS PRESENT.

4.00 INTERPRETATION

Interpretation of the seismic refraction data beyond the depth and velocity information obtained above includes general relationships between the different geological elements of the area in terms of bulk density of the materials and the effects of bulk density upon seismic velocities. Identification of rock types or the character of other deposits from the seismic data is done on the basis of increasing seismic velocity with increasing bulk density, supported by experience showing types of materials encountered in areas where prior seismic investigations have been made. For this particular investigation, the following relationships are expected:

Refraction Velocity (feet/second)	Materials Indicated
4800-5400	Soft, unconsolidated sediments of silts, sands, and clays. Fully water saturated and readily excavated.
6200-9600	Moderately hard to hard glacial till, including clay, silt, sand, gravel, and possibly boulders. May include some deeply weathered bedrock. Moderately difficult to difficult to excavate, may require explosives in upper part of velocity range.
13200-17200	Hard, dense, and competent bed- rock, expected to be gneiss and schist. Will require explosives for excavation except in a few isolated weathered zones.

The calculations referenced in Section 3.00 provide depth and velocity information that are plotted directly beneath the shot point according to standard procedures. Zones and layers of differing geologic types (differing velocities) are then delineated by smoothed line extensions between the calculated conditions at each shot point.

5.00 RESULTS

Results of the marine seismic refraction profiling are shown in Figures 3 through 12 for the area investigated between the Memorial and New Hampshire & Maine Bridges. Profiles for the area north of Goat Island are shown in Figures 13 through 15. Average seismic refraction velocities are shown in the figures along with the generalized interpretation as described above.

The "between-bridge" area is typified by a layer of soft sediments over either glacial till or bedrock in the onshore part, with the soft sediment layer generally less thick and finally absent proceeding from the onshore area toward the ship channel. Glacial till appears in patches toward the central parts of the refraction alignments, with bedrock exposed on the bottom in the northerly through westerly through southerly directions around Badger's Island and along the sides and bottom areas of the ship channel.

Profiling in the Goat Island area shows bedrock at bottom in the westerly part of the area investigated, but a thick cover of glacial ? is indicated in the easterly part. Separation of these two conditions is approximately at a northeasterly line extending from the northeasternmost point on Goat Island. No significant deposits of soft unconsolidated materials are indicated by the seismic refraction data in any part of this area.

6.00 RECOMMENDATIONS

Several confirmatory borings are recommended to assure that no conditions exist that could interfere with the standard refraction profiling techniques and analytical procedures, and to check for errors caused by the tidal conditions. Primary locations for such borings are:

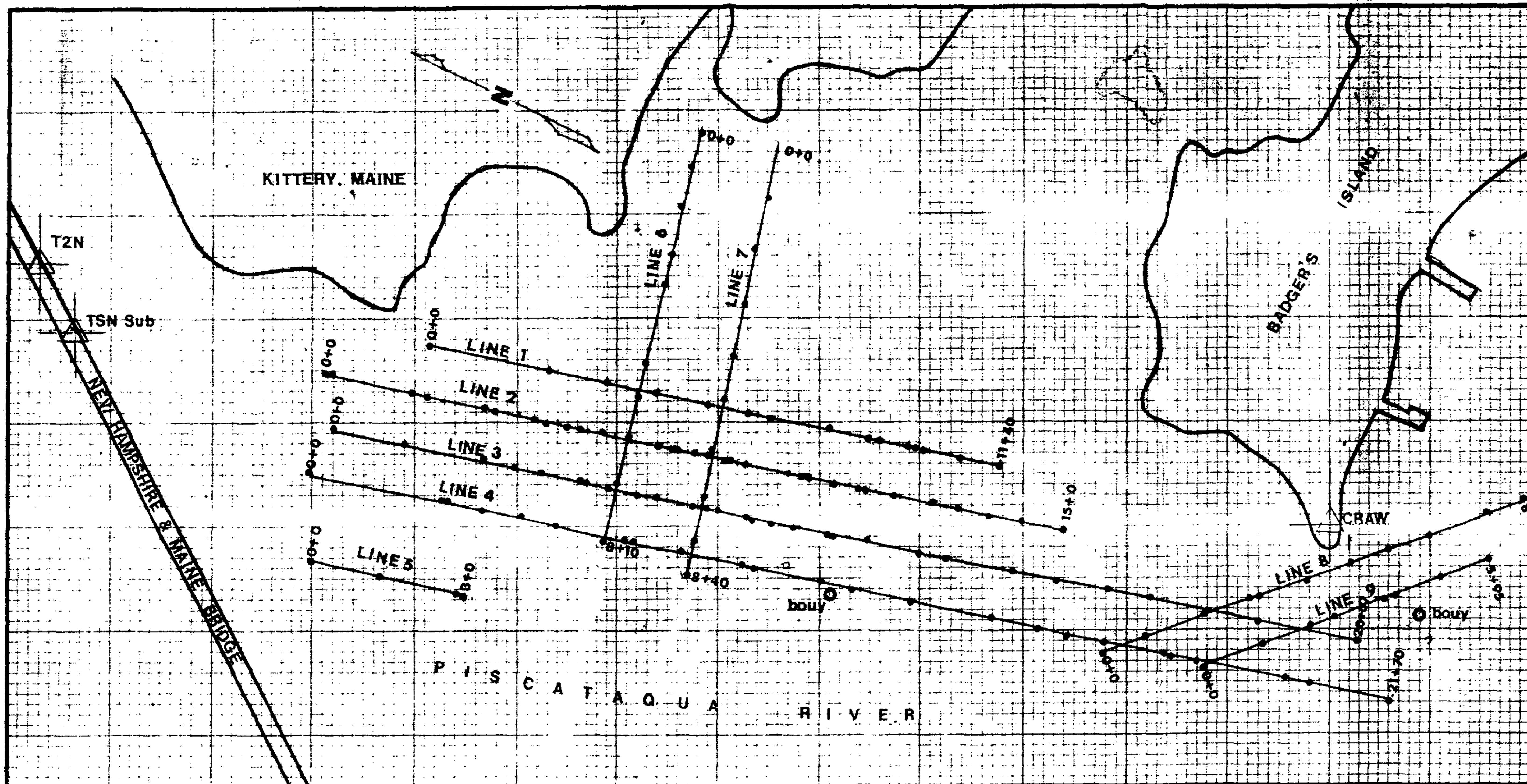
1) in the rectangular area enclosed by Lines 1, 2, 6, and 7.
2) between Lines 10 and 11 on a line between benchmarks "PRISON" and "SHAW".

Additional borings may also be taken:

3) at the intersection of Line 3 and Line 7.
4) between Lines 3 and 4, due east of the bouy northwesterly from Badger's Island.
5) in the area northerly and easterly from Goat Island where profiling could not be conducted.

These borings will also provide information about the presence or absence of any soft layers that are "transparent" to the acoustic signals (i.e., insufficient density contrast to cause reflection or refraction of the acoustical energy).

(END)



INTERFACES OR INFERRED INTERFACES BETWEEN SEISMIC VELOCITY ZONES ON THE FIGURES ABOVE ARE BASED UPON THE RESULTS OF STANDARD GEO-PHYSICAL INTERPRETATION TECHNIQUES. DEPTHS BELOW SURFACE, VELOCITY ZONE THICKNESS, AND VELOCITIES ARE INDICATIVE OF AVERAGE CONDITIONS BENEATH THE GEOPHONE SPREAD AND SHOULD BE USED FOR PLANNING PURPOSES ONLY. ESTIMATED ACCURACY OF THICKNESSES AND DEPTHS FOR THIS SURVEY IS ____–____ DEPTHS TO INFERRED SATURATED ZONES APPLY TO DEPTHS AT TIME OF SURVEY

SCALE: VERTICAL / HORIZONTAL 1" = 200'

SHOT POINTS
GEOPHONE SPREAD
INFERRED SUBSURFACE VELOCITY BOUNDARIES
SEISMIC WAVE VELOCITIES IN FEET PER SECOND

1600
4700
10200

Piscataqua River

SEISMIC SURVEY PROFILES
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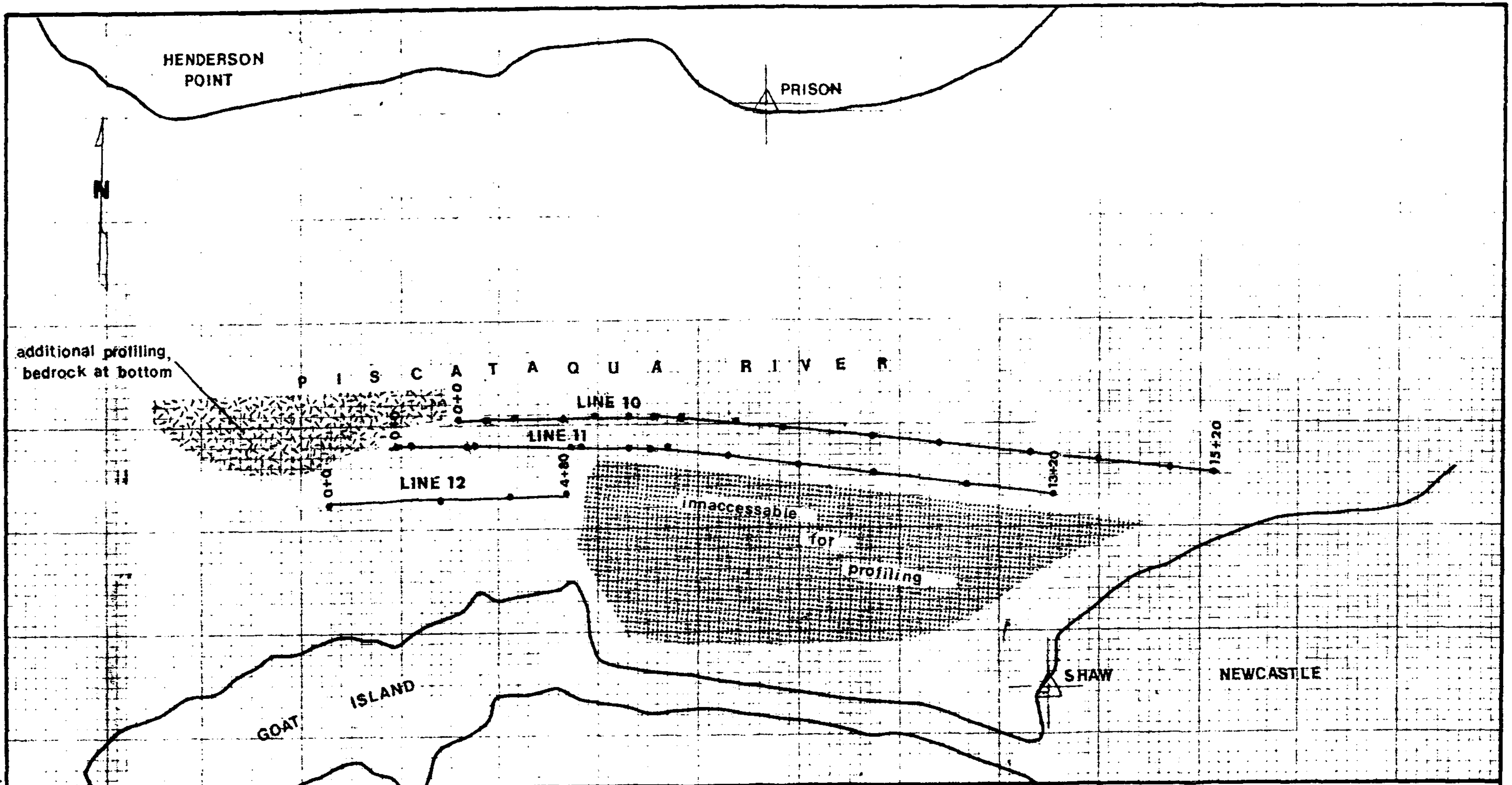
T1S

FIGURE 1



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SCALE: VERTICAL / HORIZONTAL 1"=200'

SHOT POINTS
GEOPHONE SPREAD
INFERRED SUBSURFACE VELOCITY BOUNDARIES
SEISMIC WAVE VELOCITIES IN FEET PER SECOND

1600
4700
10200

Piscataqua River

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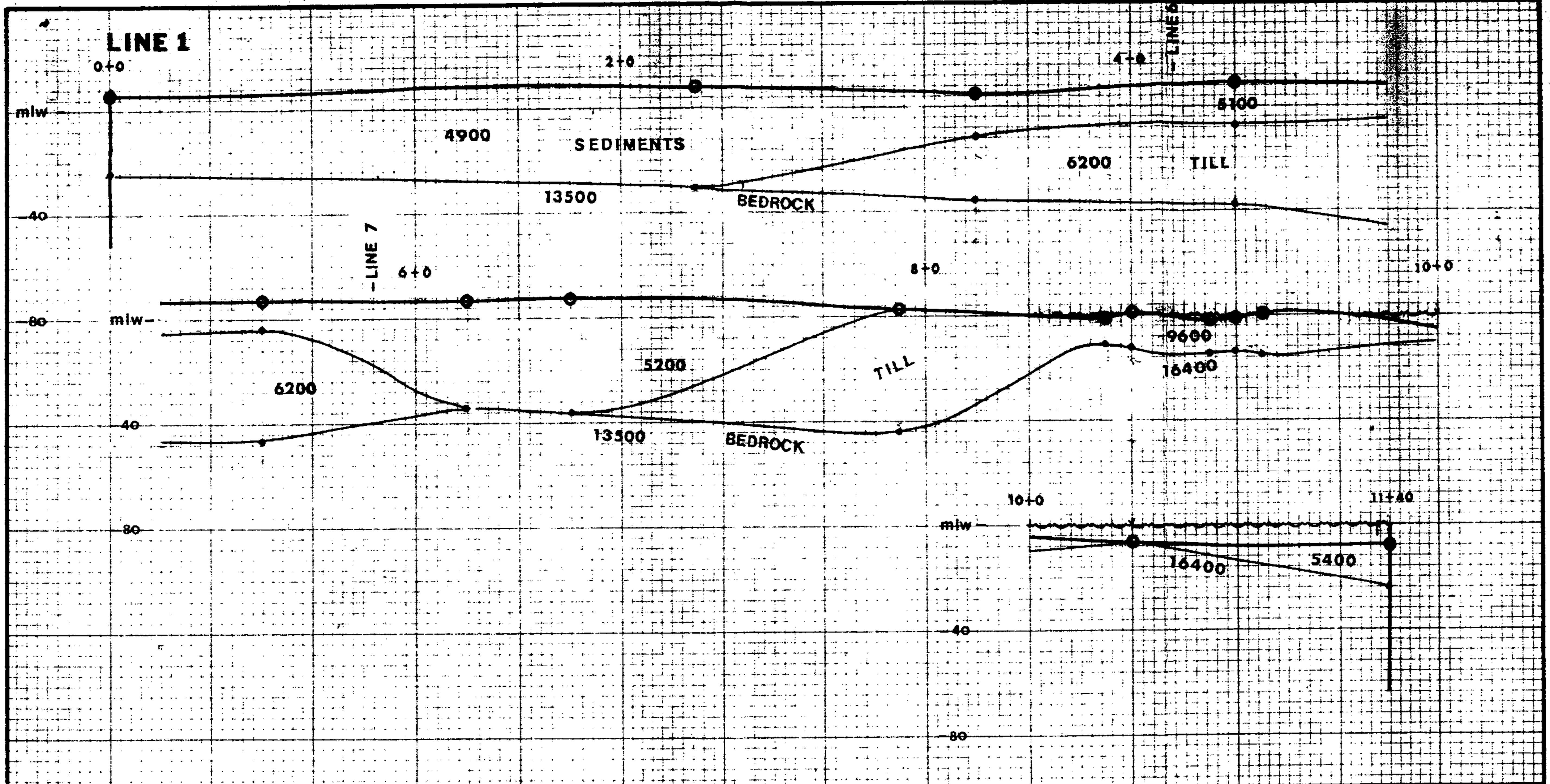
FIGURE 2



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SCALE: VERTICAL / HORIZONTAL 1"=40'

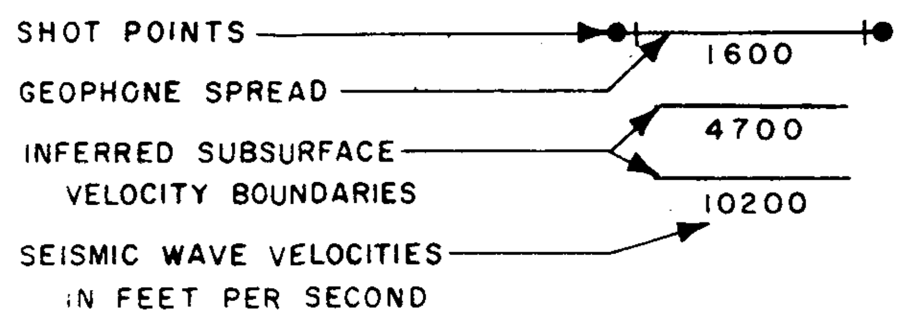

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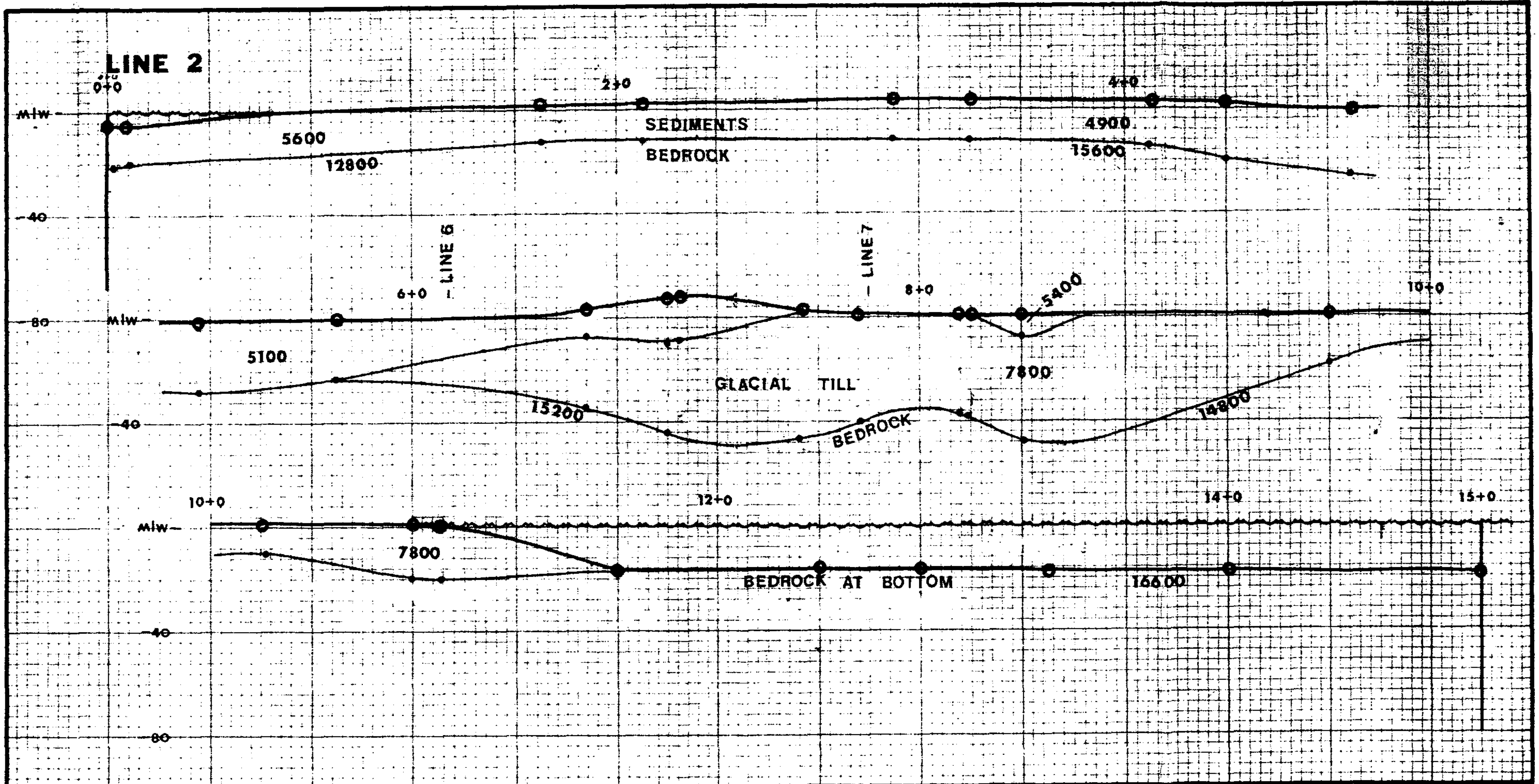
FIGURE 3



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SCALE: VERTICAL / HORIZONTAL 1" = 40'

SHOT POINTS
GEOPHONE SPREAD
INFERRED SUBSURFACE VELOCITY BOUNDARIES
SEISMIC WAVE VELOCITIES IN FEET PER SECOND

1600
4700
10200

Piscataqua River

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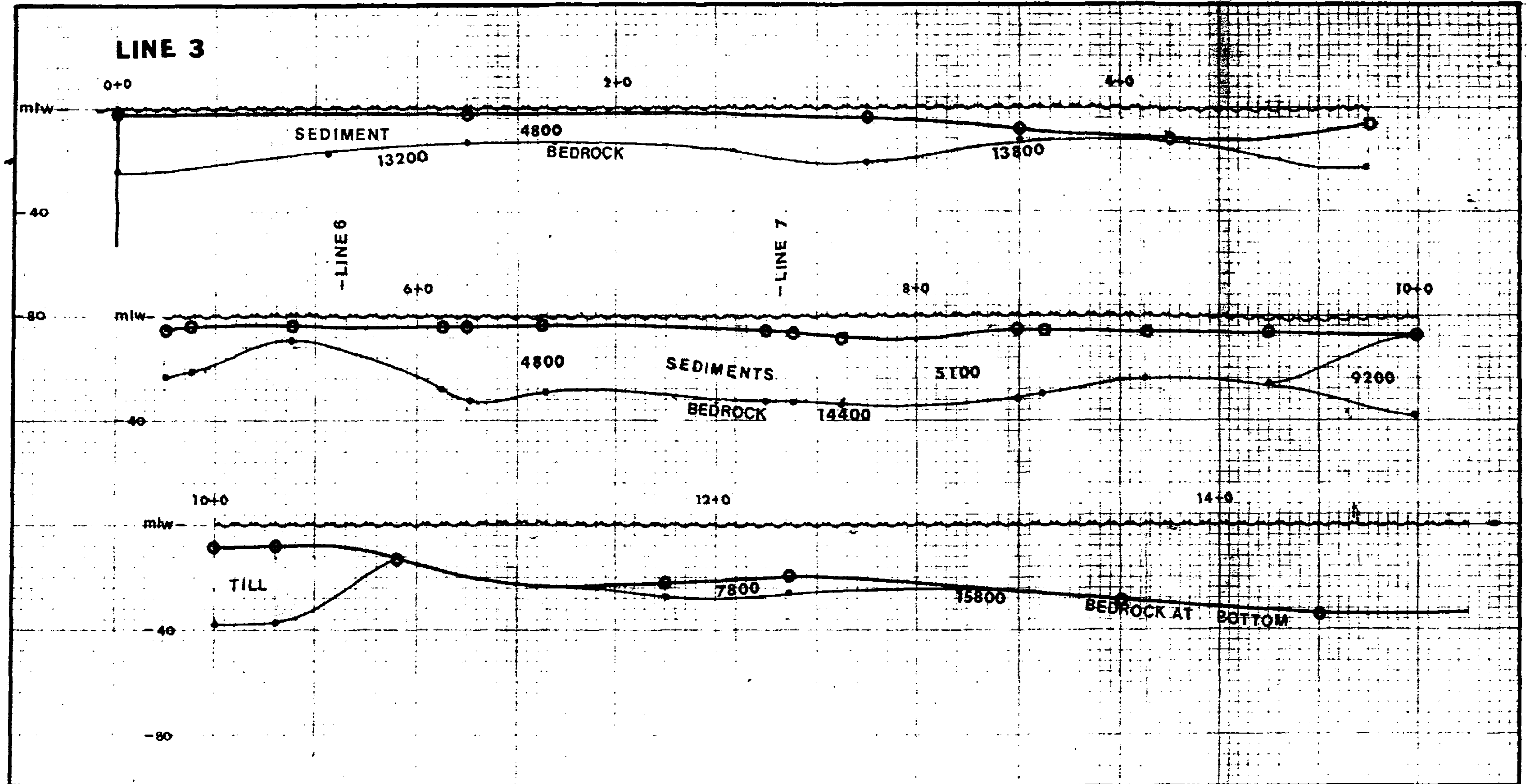
FIGURE 4



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SCALE: VERTICAL 1" = 40'
HORIZONTAL

SHOT POINTS
GEOPHONE SPREAD
1600
INFERRED SUBSURFACE VELOCITY BOUNDARIES
4700
10200
SEISMIC WAVE VELOCITIES IN FEET PER SECOND

Piscataqua River

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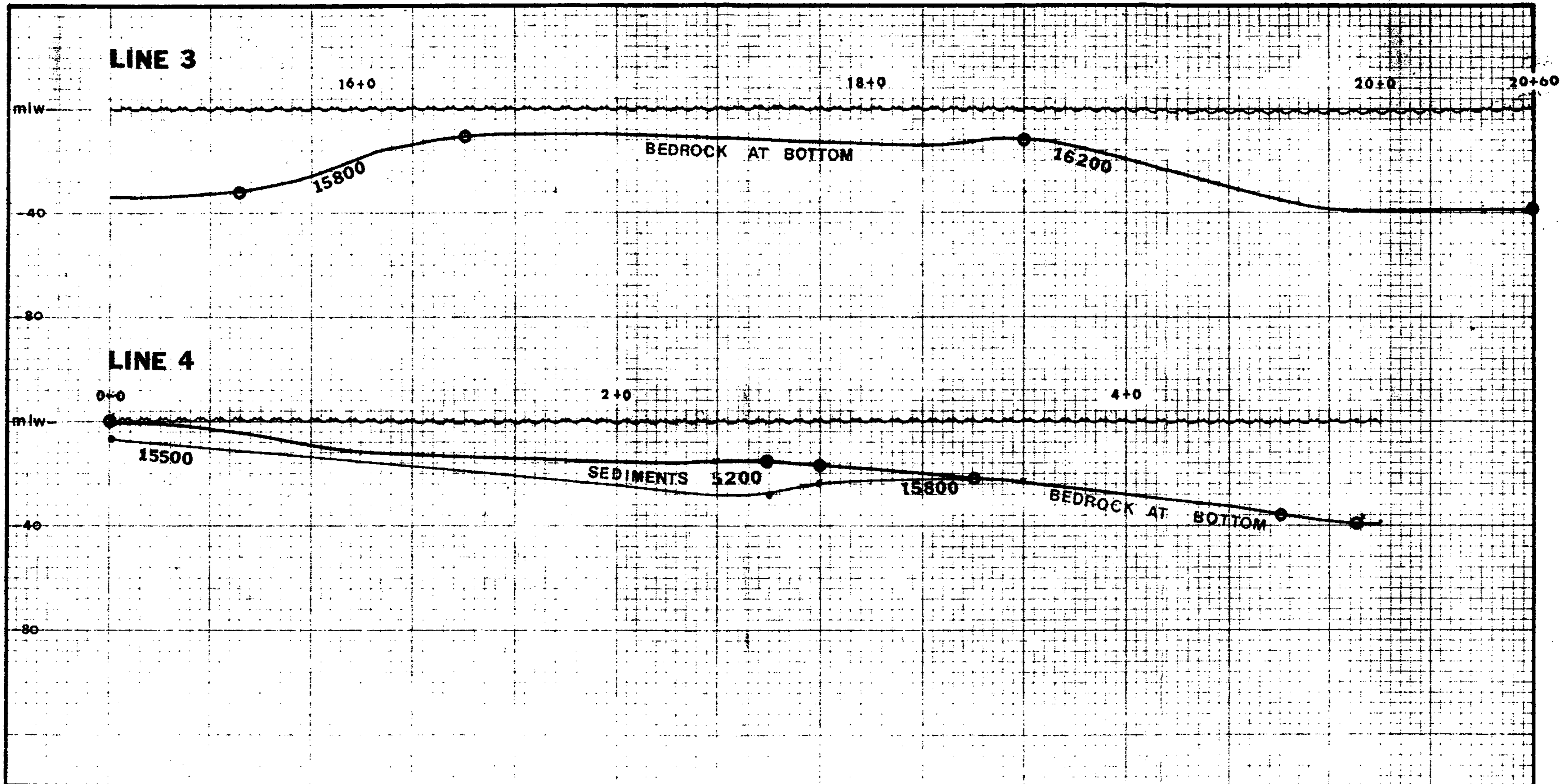

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SCALE: VERTICAL / HORIZONTAL 1"=40'

SHOT POINTS
GEOPHONE SPREAD
INFERRED SUBSURFACE VELOCITY BOUNDARIES
SEISMIC WAVE VELOCITIES IN FEET PER SECOND

1600
4700
10200

Piscataqua River

SEISMIC SURVEY PROFILES

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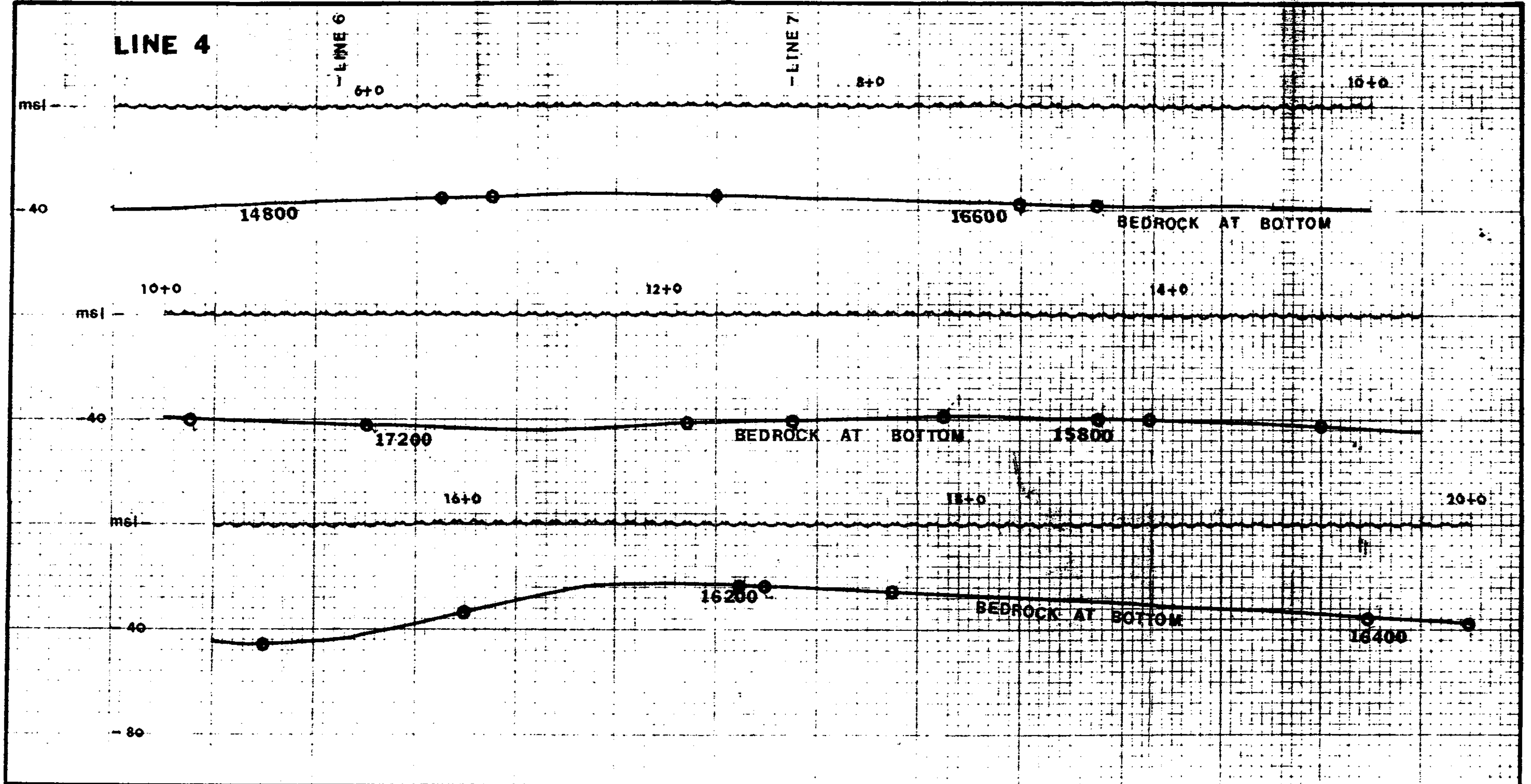

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SCALE: VERTICAL 1" = 40'
HORIZONTAL

SHOT POINTS
GEOPHONE SPREAD
INFERRED SUBSURFACE VELOCITY BOUNDARIES
SEISMIC WAVE VELOCITIES IN FEET PER SECOND

1600
4700
10200

Piscataqua River

SEISMIC SURVEY PROFILES
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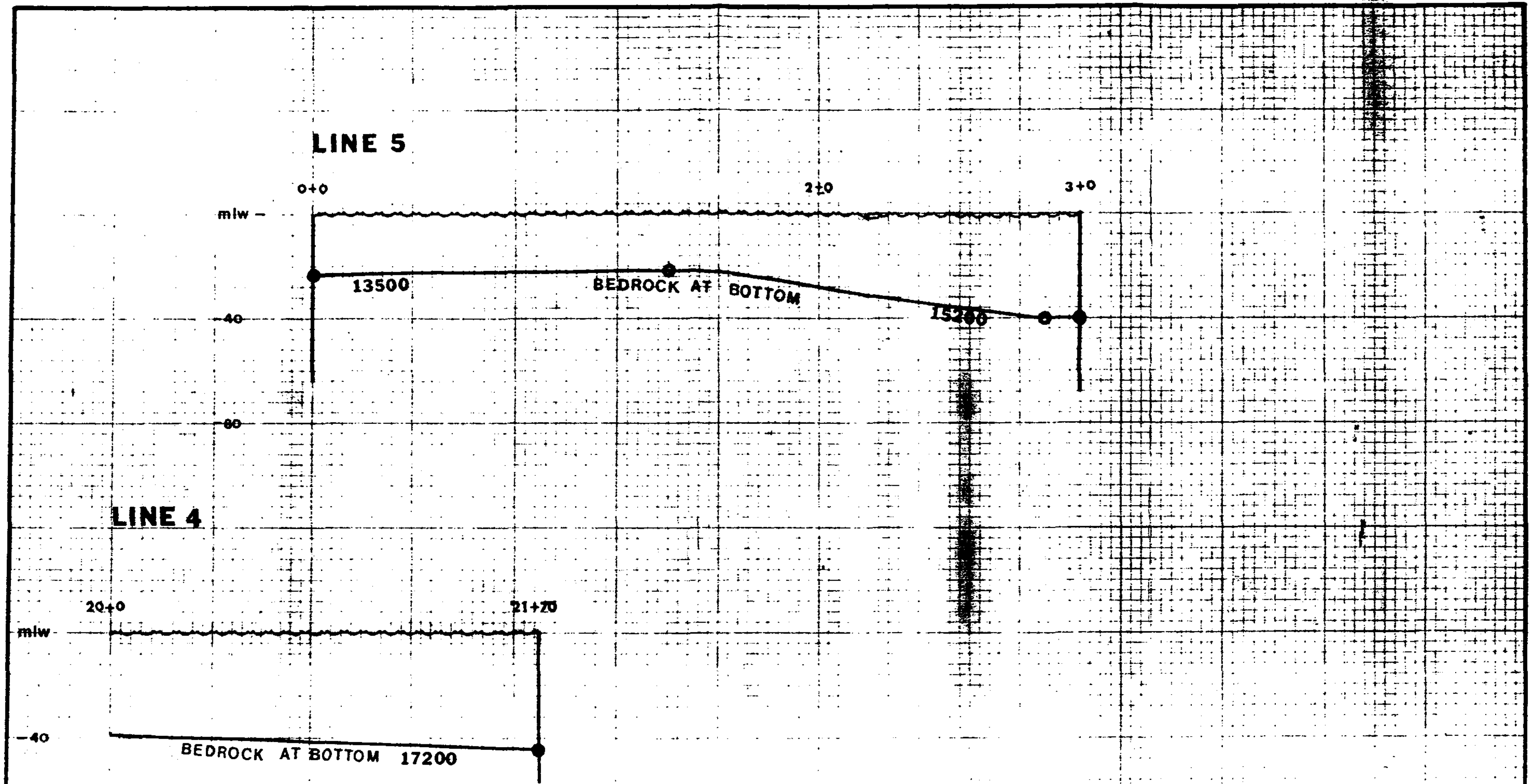
FILE NO. 7760

FIGURE 7



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SCALE: VERTICAL 1"=40'
HORIZONTAL

SHOT POINTS
GEOPHONE SPREAD
INFERRED SUBSURFACE VELOCITY BOUNDARIES
SEISMIC WAVE VELOCITIES IN FEET PER SECOND

1600
4700
10200

Piscataqua River

SEISMIC SURVEY PROFILES

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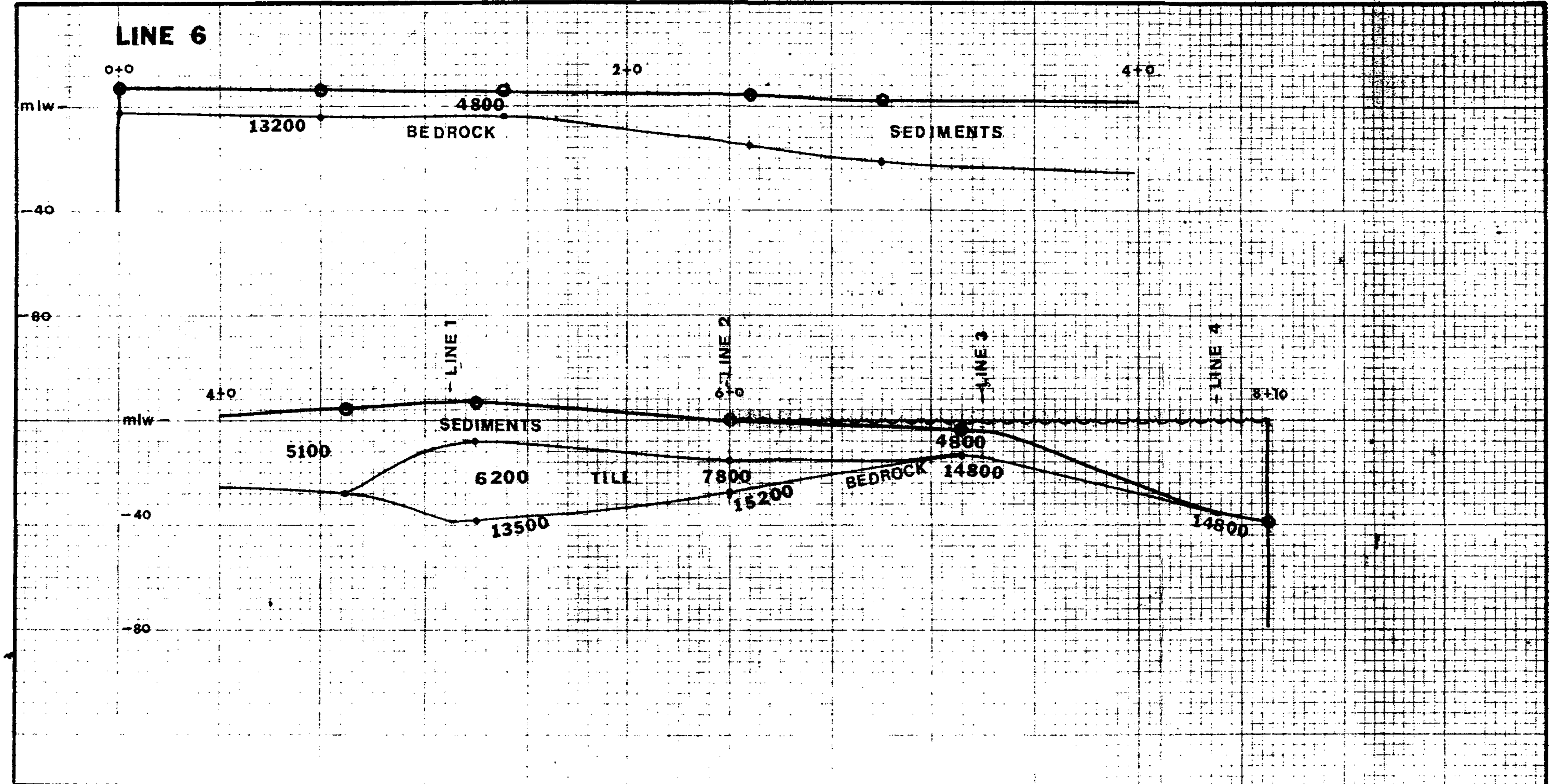
S.A. ALSUP ASSOC.
Waban, Mass.

FILE NO 7760

FIGURE 8



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SCALE: VERTICAL / HORIZONTAL 1" = 40'

SHOT POINTS
GEOPHONE SPREAD
INFERRED SUBSURFACE VELOCITY BOUNDARIES
SEISMIC WAVE VELOCITIES IN FEET PER SECOND

1600
4700
10200

Piscataqua River

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Waban, Mass.

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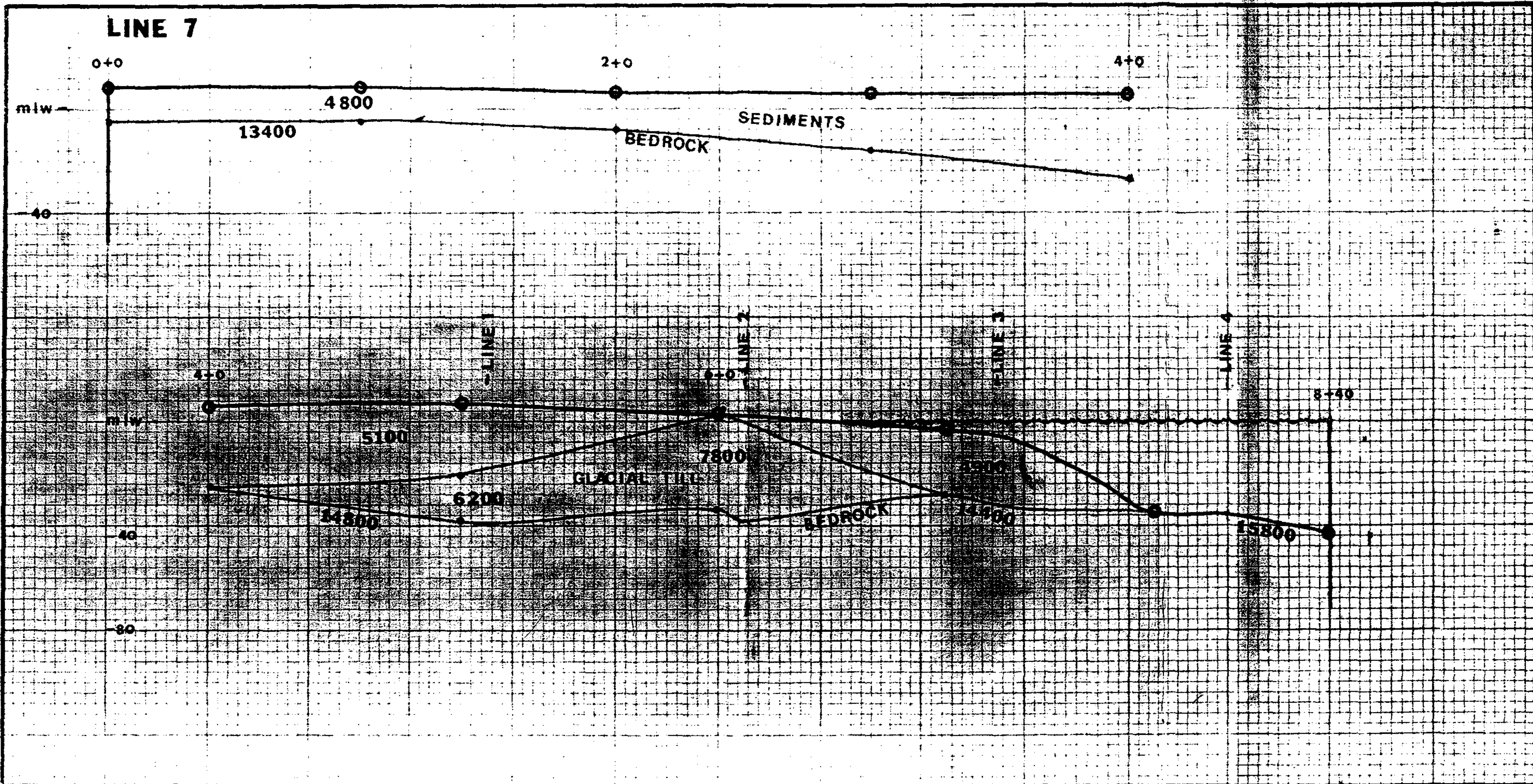
FIGURE 9



INTERFACES OR INFERRED INTERFACES BETWEEN SEISMIC VELOCITY ZONES ON THE FIGURES ABOVE ARE BASED UPON THE RESULTS OF STANDARD GEO-PHYSICAL INTERPRETATION TECHNIQUES. DEPTHS BELOW SURFACE, VELOCITY ZONE THICKNESS AND VELOCITIES ARE INDICATIVE OF AVERAGE [illegible] UND BENEATH THE GEOPHONE SPREAD AND [illegible] BE USED FOR PLANNING PURPOSES ONLY [illegible] ACCURACY OF THICKNESSES AND DEPTHS [illegible] [illegible] ± 10 [illegible]

SCALE: VERTICAL 1"=40' HORIZONTAL

SHOT POINTS

[illegible] 1600

[illegible] 4700

[illegible] 0200

[illegible]

Piscataqua River

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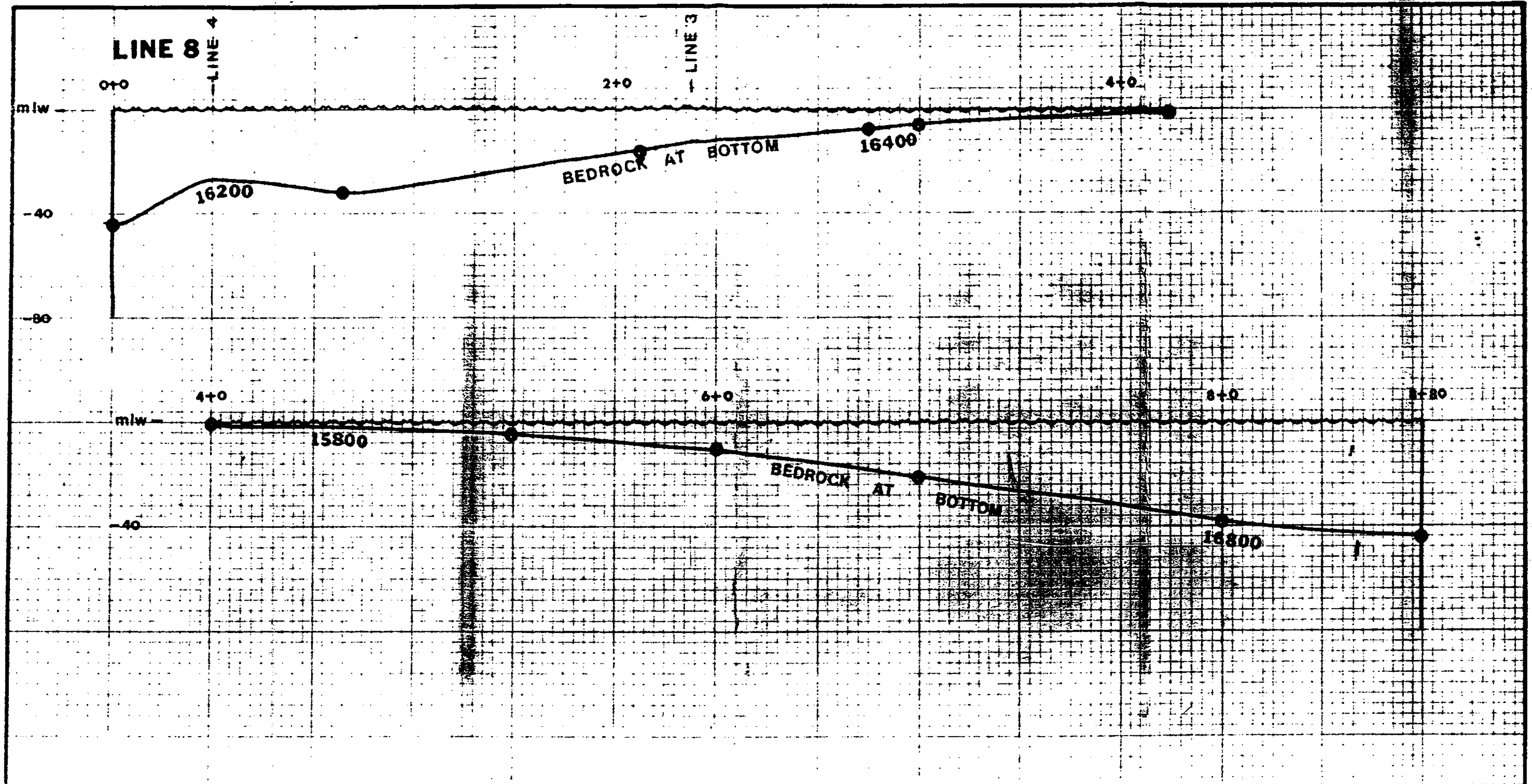
FIGURE **10**



INTERFACES OR INFERRED INTERFACES BETWEEN SEISMIC VELOCITY ZONES ON THE FIGURES ABOVE ARE BASED UPON THE RESULTS OF STANDARD GEO-PHYSICAL INTERPRETATION TECHNIQUES. DEPTHS BELOW SURFACE, VELOCITY ZONE THICKNESS, AND VELOCITIES ARE INDICATIVE OF AVERAGE CONDITIONS BENEATH THE GEOPHONE SPREAD AND SHOULD BE USED FOR PLANNING PURPOSES ONLY. ESTIMATED ACCURACY OF THICKNESSES AND DEPTHS FOR THIS SURVEY IS ±10%. DEPTHS TO INFERRED SATURATED ZONES APPLY TO DEPTHS AT TIME OF SURVEY.

SCALE: VERTICAL / HORIZONTAL 1" = 40'

SHOT POINTS
GEOPHONE SPREAD
INFERRED SUBSURFACE VELOCITY BOUNDARIES
SEISMIC WAVE VELOCITIES IN FEET PER SECOND

1600
4700
10200

Piscataqua River

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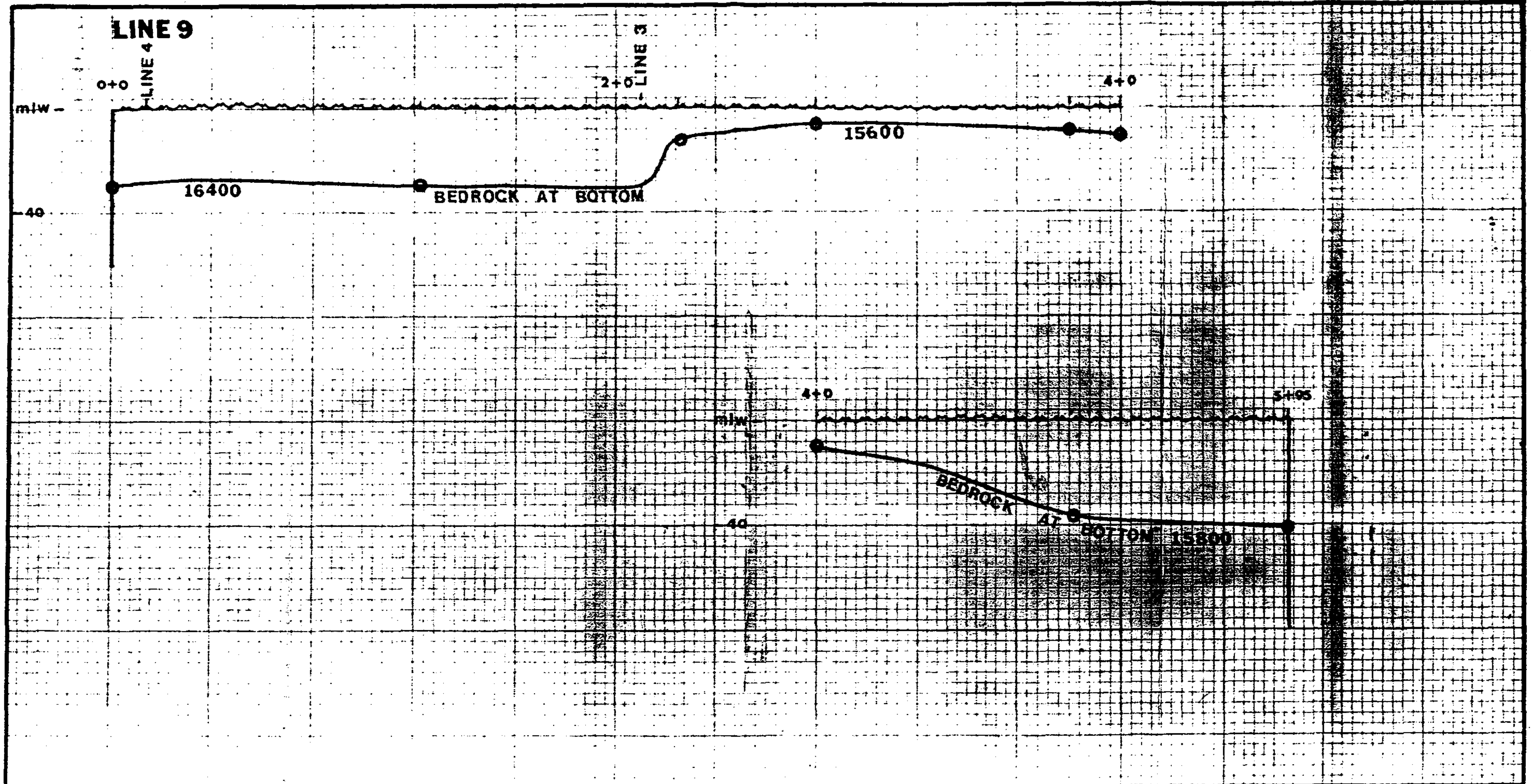
FILE NO. 7760

FIGURE 11



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SCALE: VERTICAL / HORIZONTAL 1" = 40'

SHOT POINTS
GEOPHONE SPREAD
INFERRED SUBSURFACE VELOCITY BOUNDARIES
SEISMIC WAVE VELOCITIES IN FEET PER SECOND

1600
4700
0200

Piscataqua River

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GEOPHYSICAL SERVICES DEPARTMENT

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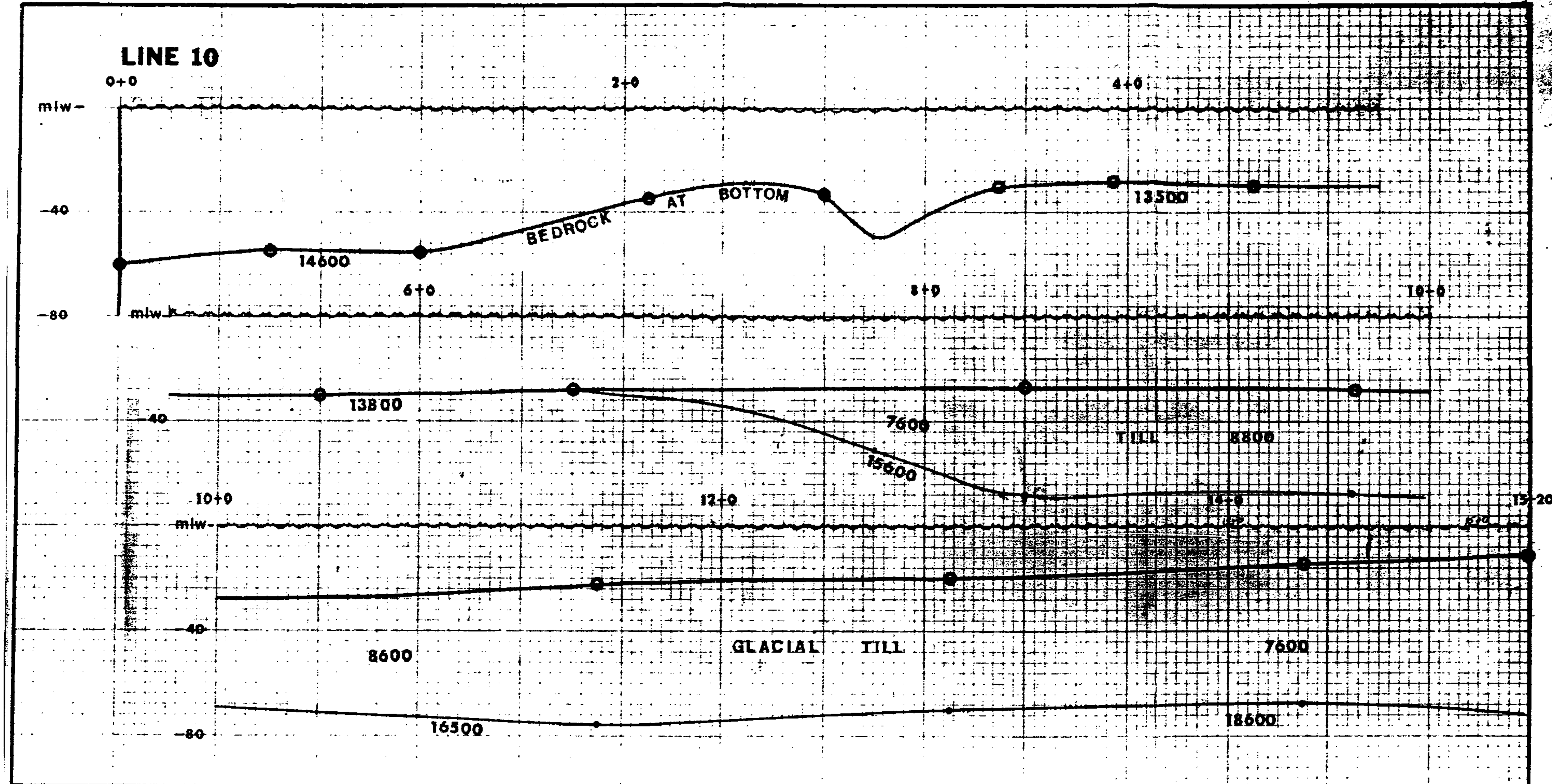
FILE NO 7760

FIGURE 12



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SCALE: VERTICAL / HORIZONTAL 1" = 40'

SHOT POINTS

GEOPHONE SPREAD

INFERRED SUBSURFACE VELOCITY BOUNDARIES

SEISMIC WAVE VELOCITIES IN FEET PER SECOND

1600

4700

6200

Piscataqua River

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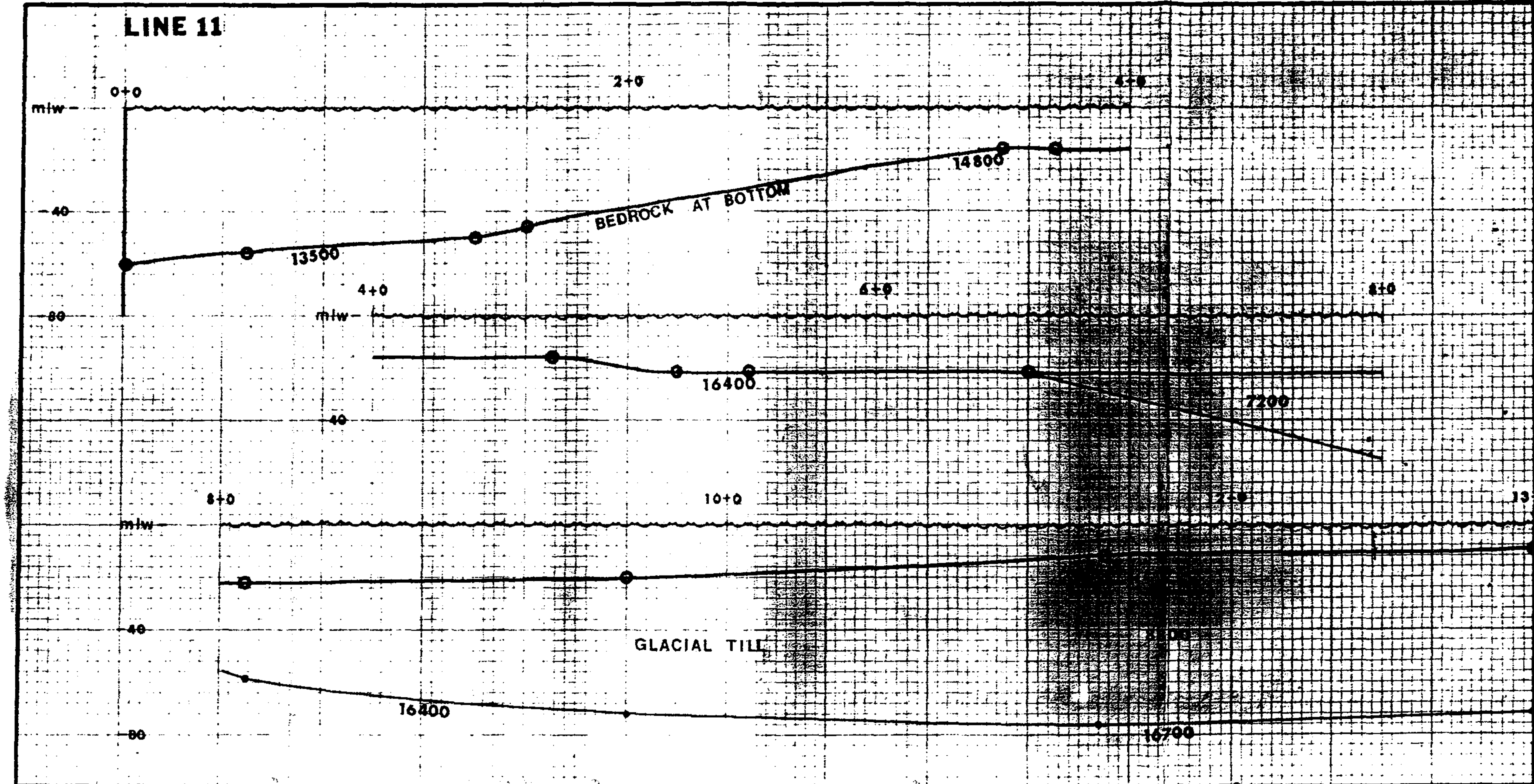
FILE NO 7760

FIGURE 13



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SCALE: VERTICAL / HORIZONTAL 1" = 40'

SHOT POINTS

GEOPHONE SPREAD

INFERRED SUBSURFACE VELOCITY BOUNDARIES

SEISMIC WAVE VELOCITIES IN FEET PER SECOND

1600

4700

10200

Piscataqua River

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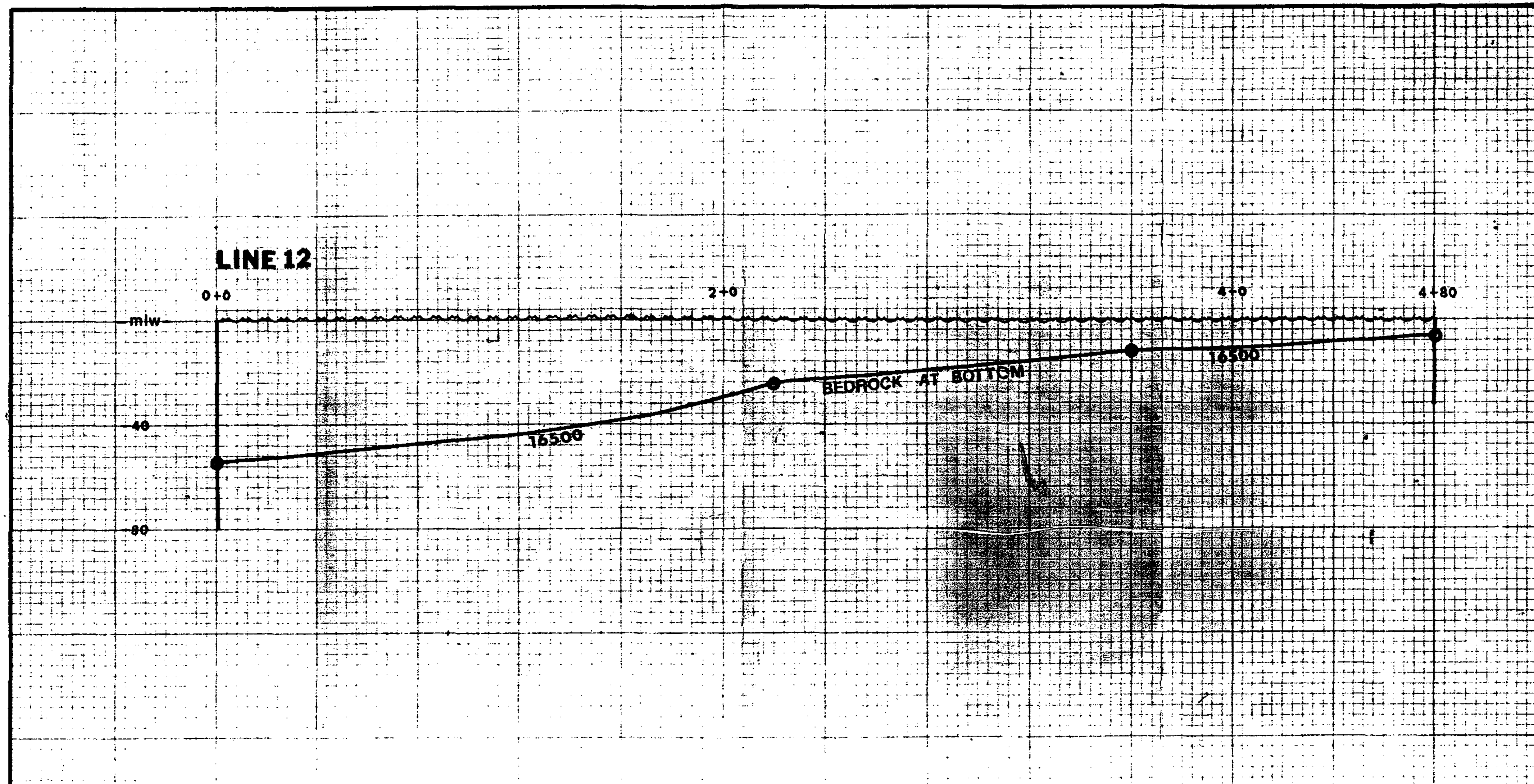
FILE NO 7760

FIGURE 14



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SCALE: VERTICAL 1" = 40'
HORIZONTAL

SHOT POINTS
GEOPHONE SPREAD
INFERRED SUBSURFACE VELOCITY BOUNDARIES
SEISMIC WAVE VELOCITIES IN FEET PER SECOND

1600
4700
0200

Piscataqua River

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FILE NO. 7760

FIGURE **15**

II PLATES

CORPS OF ENGINEERS

U. S. ARMY

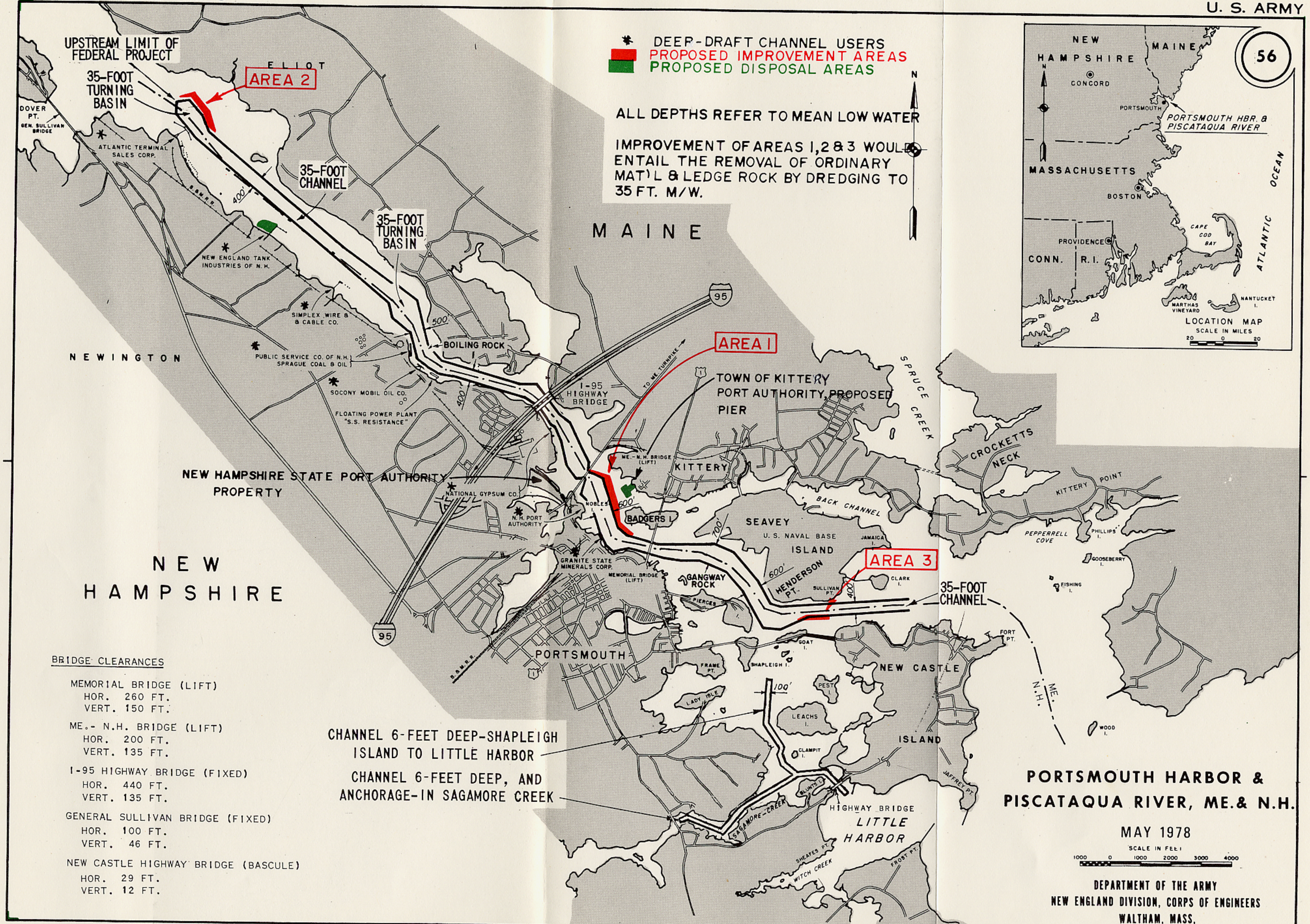
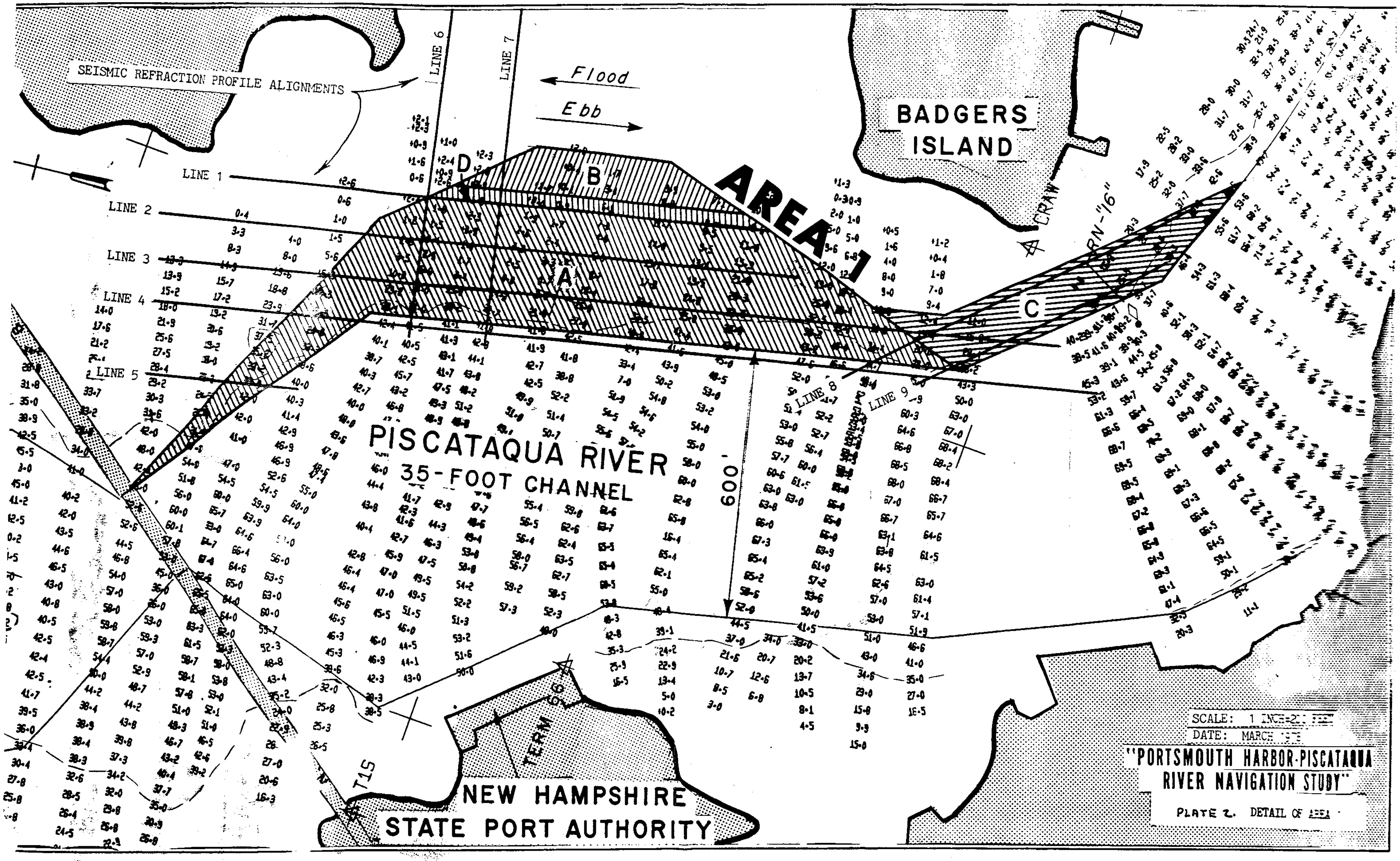
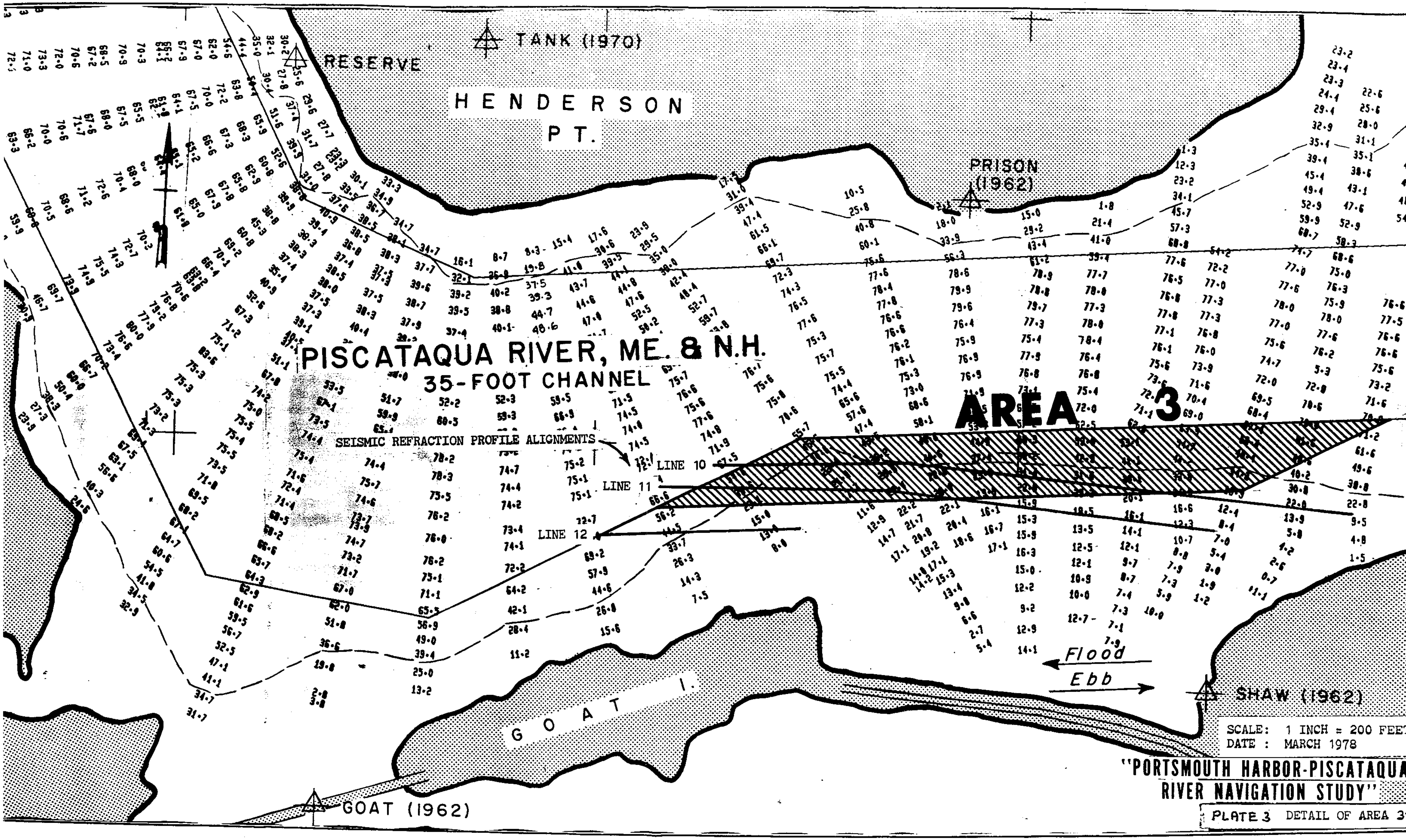


PLATE 1

OF ENGINEERS NED




TANK (1970)
RESERVE
HENDERSON
PT.
PRISON
(1962)
PISCATAQUA RIVER, ME. & N.H.
35-FOOT CHANNEL
AREA 3
SEISMIC REFRACTION PROFILE ALIGNMENTS
LINE 10
LINE 11
LINE 12
Flood
Ebb
GOAT I.
SHAW (1962)
GOAT (1962)
SCALE: 1 INCH = 200 FEET
DATE : MARCH 1978
"PORTSMOUTH HARBOR-PISCATAQUA
RIVER NAVIGATION STUDY"
PLATE 3 DETAIL OF AREA 3

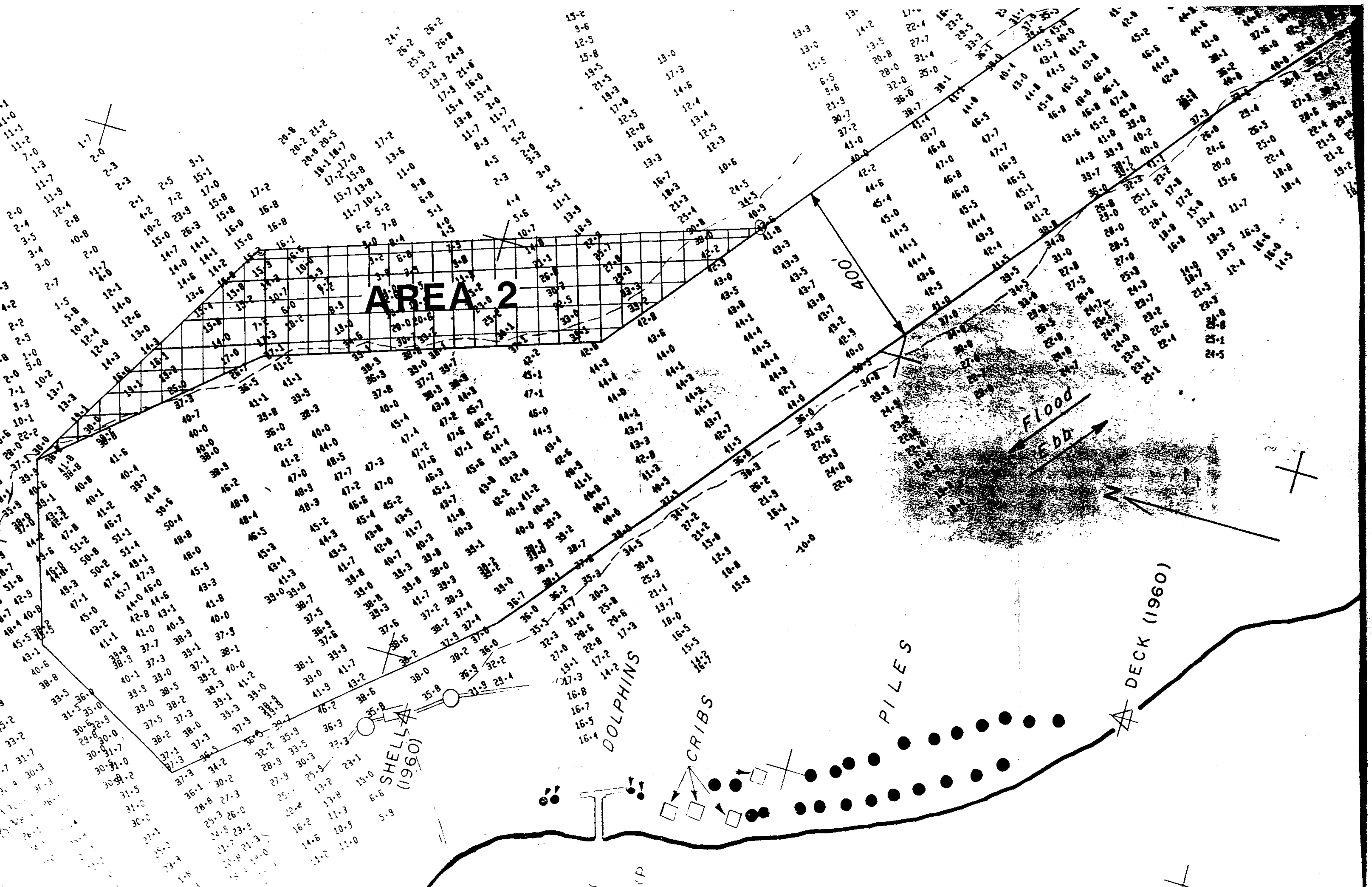

AREA 2
400'
Flood
Ebb
N
DECK (1960)
PILES
CRIBS
DOLPHINS
SHELL (1960)

PLATE 4